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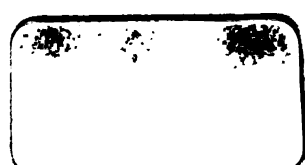
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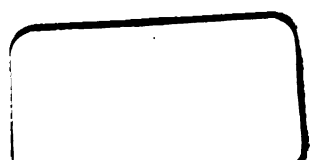
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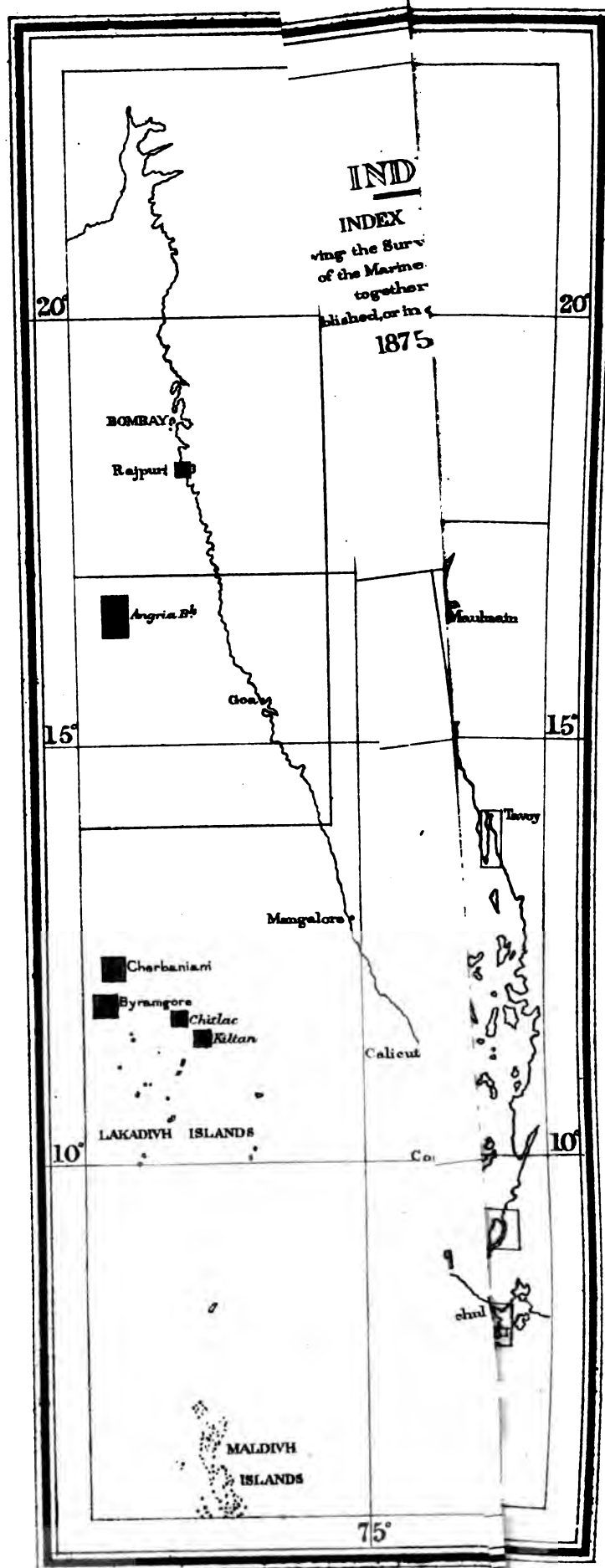
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GENERAL REPORT

OF THE OPERATIONS OF

The Marine Survey of India,

FROM

THE COMMENCEMENT IN 1874, TO THE END OF THE
OFFICIAL YEAR 1875-76.

PREPARED FOR SUBMISSION TO THE GOVERNMENT OF INDIA

BY

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SECTION I.

GENERAL REPORT.

As this is the first Annual Report of the operations of the Marine Survey Department, since the sanction for its formation was granted by Her Majesty's Secretary of State for India, on the representation of the Indian Government in 1874, it would, perhaps, be as well if, instead of confining my report solely to the actual surveys which have been executed, and the outturn of work in the Drawing Branch and Office, I should first place on record the steps which were taken towards organizing the department from the commencement, and also the ultimate form it assumed, from both necessary and unavoidable changes which occurred during the first year of its working.

1. In 1871, the necessity for improving the existing charts of the Indian coasts, and executing new surveys, owing to the increased development of the ocean and coasting trade of India, and the urgent call for exact knowledge regarding the capabilities of its harbours, became so pressing as to induce Parliament, as well as the public, to turn their attention to the lamentable state of Indian hydrography.

Attention drawn to the pressing necessity for new surveys in India.

2. Since the abolition of the Indian Navy, and the transfer from the India Office to the Admiralty of all the materials for the construction of charts in 1861, up to the year 1871, a period of ten years, little or nothing had been done, with the exception of certain desultory operations undertaken by the different local Governments as the need arose, without any combined plan, with inadequate means, and in most cases the work was left in the hands of persons who were quite unacquainted with nautical surveying, except in its rudest form.

3. Extraordinary changes had taken place in the configuration of the coast, in many localities, since the surveys executed some 30 to 50 years previously. Lights, buoys, beacons, &c., had been erected. Ports which were of no importance then, and the examination of which consequently had been but cursory, had now become open to commerce, and yet the charts remained the same, and were practically useless. It was also pointed out that the surveys of half a century, or more, ago were merely preliminary examinations, and could not in the first instance, without steam-boats and trained officers, have been executed in the precise manner in which surveys are now carried out by the Surveyors of the Royal Navy, the rigorous exactitude of which is absolutely necessary for the requirements of the present advanced state of navigation and commerce.

4. The urgent necessity for immediate action was pointed out by Mr. Clements Markham, C.B., F.R.S., in an exhaustive memoir, which was submitted, with other memoranda, by Mr. Trelawney Saunders, Geographer to the India Office, Captain Constable, L.N., myself and others, for the consideration of Her Majesty's Secretary of State for India, the Duke of Argyll.

Mr. Markham's official position at the India Office and extensive knowledge of the subjects included under the general head of Geography, eminently qualified him for the task of reviewing the past and present state of Indian hydrography, and giving valuable suggestions on the necessary steps to be taken to remedy existing evils.

5. In the early part of 1871, the Secretary of State, in a despatch forwarding the above memoir, &c., brought this important subject to notice, and requested the earliest and serious attention of the Government of India, asking, at the same time, for opinions and suggestions, as to the measures to be adopted for providing some efficient substitute for the establishments formerly maintained for the survey of the Indian seas.

6. The Government of India, before giving any decided answer, suggested that I should be sent out to India to assist in devising suitable measures to remedy the inconveniences pointed out. This proposal was approved of by Her Majesty's Secretary of State, and I arrived in Calcutta in December 1873.

7. Under the direction of the Government, I prepared a review of all existing charts, or materials for charts, in India or in England, of the coast from Pakchan Estuary to Sonmiani Bay, as also of the islands in the Bay of Bengal, the Laccadives and Maldives; also, a scheme to supplement and perfect existing charts, both by working up materials, not then utilized, and by new surveys, and fully detailing for each the method in, and the agency by, which it should be carried out, and its probable cost.

8. After full enquiry and consultation with the marine authorities, and others interested in the coasting trade and approaches to our coast and harbours, I submitted a report of the measures which, in my judgment, were required. This report was substantially adopted by the Government of India which accepted the responsibility of completing and maintaining the charts of the Indian coast, from Pakchan Estuary, at the southern extremity of Tenasserim, to Sonmiani Bay, on the western limits of the Sind coast, of the Andaman and Nicobar Islands, the Mergui Archipelago and the Laccadives.

9. Her Majesty's Secretary of State for India was thereupon asked for a special agency—

1st.—To undertake accurate surveys of localities not yet sufficiently surveyed.

2nd.—To work up the results of these surveys, and of other existing surveys, the materials of which have never yet been fully utilized.

3rd.—To maintain the accuracy of our charts, by recording and bringing to notice all changes in the first instance of buoys, lights, and the like; and secondly, from time to time, of the natural configuration of the seaboard consequent on natural changes.

10. The proposals of the Government of India were very briefly as follows:—

That, with the view of executing gradually all the more pressing marine surveys and re-surveys, within the limits for which the Indian Government accepted the responsibility, a small survey flotilla should be organized with competent surveyors and efficiently manned, the whole cost of which, including a Superintendent of Marine Surveys, should not exceed two lakhs of rupees per annum.

That, to supervise both the carrying on of the surveys afloat, the draughting of the charts for publication, to superintend the reproduction by photozincography, or their preparation for transmission to the Hydrographer, to maintain a correct record of buoys, lights and the like, and publish the earliest information of changes in the position of these, a Superintendent of Marine Surveys should be appointed.

11. It was also proposed that I should return to England, *via* Bombay,*

that I might be available to furnish the Secretary of State with any further details which might be necessary, in order to finally arrange for the manner in which the services of Officers of the Royal Navy might be secured. During my stay at Bombay, I made it my duty to bring the question of missing original charts before many of the officers who had formerly served in local situations

Duties at Bombay and in England.

* There I was detained nearly three weeks, being appointed member of a committee under the presidency of Colonel Alexander Fraser, R.E., C.B., to report upon the hydraulic lift at Hog Island.

connected with the Dockyard and the Observatory, where the Indian Navy Draughtsman's office was located. The result was that a great number of valuable documents were found at the time; a few of these I took to England and deposited at the India office; amongst them were original maps of Mesopotamia, which Captain Felix Jones, I.N., found of use in the compilation of his new great map of Arabia. But after securing these, from information received at the store-keeper's office, I reported to the Government of India a contemplated wholesale destruction of some 3,000 old charts because of their being dust-stained, torn and insect-eaten; my suggestion was (and fortunately it came in time to be carried out) that these charts should be sent to Calcutta to await my return. This proved a real treasure-trove; many invaluable original charts were preserved from destruction and now are carefully stored at Calcutta and catalogued. Three or four originals, on a large scale, of portions of Captain Moresby's survey of the Red Sea were discovered, copies of which have been forwarded to the Hydrographer.

12. The proposal of the Government of India for the resumption of Marine Surveys, together with the scheme submitted based on my report, preceded me to England, and was there sanctioned by Her Majesty's Secretary of State for India in Council in a despatch dated 16th

Sanction of Secretary of State.

July 1874, and I was appointed Superintendent of Marine Surveys on the 27th July of the same year.

13. In accordance with the scheme, the Lords Commissioners of the Admiralty were communicated with on the subject of appointing Officers of the Surveying Branch of the Royal Navy to fill the superior posts in this Department under the Government of India. The proposals met with the approval of their Lordships, and after some further correspondence between the India Office and the Admiralty, settling the necessary details of the conditions under which the services of these Officers were to be placed at the disposal of the Indian Government, six Navigating Officers, *viz.*, one Staff Commander, three Navigating Lieutenants, and two Navigating Sub-Lieutenants, were, on the nomination of the Hydrographer of the Admiralty, ultimately selected and appointed. I also informed the Secretary of State that no one in India with scientific training could be found competent to utilize the mass of original documents which had been discovered in England and India, or to undertake the compilation and production of charts ready for publication. Only a person who had had long experience in this particular branch would be of any value, and upon my representations the Secretary of State, with the approval of the Admiralty, appointed Mr. R. C. Carrington, who had served 16 years in the Hydrographic Department, as my Chief Civil Assistant. This title was subsequently altered by the Government of India, with sanction from the Secretary of State (18th May 1876), to "Superintendent of the Drawing Branch."

Appointment of Admiralty Surveyors and Chief Civil Assistant.

14. During the time the negotiations with the Admiralty were going on, my time was devoted to the examination of all the original drawings of the surveys of this country, principally executed by Officers of the old Indian Navy, but many of which had hitherto remained unutilized. These were noted for early publication in our new Department. I also examined all the

Collection and examination of original documents and copper-plates at the Admiralty.

existing charts of India, published by the Admiralty, collected the necessary books of reference, instruments, &c., &c., which could not be obtained in India, and a supply of Admiralty charts and sailing directions for transmission to our head-quarters at Calcutta, and saw completed and shipped two steam-cutters to be furnished to the vessels of the survey.

15. After settling all the above details I left England on the 23rd December 1874, in company with Staff Commander Ellis, R.N., who had been appointed Deputy Superintendent. Proceeding *via* Brindisi, I arrived at Bombay on the 15th January 1875.

Return to India.

16. The two vessels "*Clyde*" (steamer) and "*Constance*" (schooner), which had been fitted in the dockyard at Bombay for surveying service, by order of the Government of India, were nearly ready for sea on my arrival.

They were completed with all possible despatch, and on the 2nd February the "*Clyde*" under the temporary command of Staff Commander Ellis, R.N., left for the Laccadive Islands *en route* for Calcutta.

The "*Constance*," in temporary charge of Mr. M. Chapman, I.N., who had commanded this vessel for three years while surveying in the Persian Gulf, under the orders of the Bombay Government, left on the 29th January for Kolachel.

17. Having despatched these vessels, I proceeded from Bombay by rail to Calcutta, arriving on the 7th February, when I at once commenced to organize my office.

18. Two vessels had been selected to be fitted out by the Kidderpore dockyard authorities for surveying service, *viz.*, the "*Guide*" (brig) and the "*Lady Lawrence*" (schooner). On my arrival, I inspected these

Surveying vessels fitted at Calcutta.

vessels and found that, though the former had been in the hands of the dockyard since October 1874, very little had been done towards preparing her for surveying service. This may be accounted for principally by the death, in October 1874, of Mr. W. Pearson, Assistant Superintendent, 1st grade, whose duty it was to have superintended the fitting-out of the vessels. After his death, there was no one on the spot who possessed the requisite experience to whom that duty could be delegated. The internal fittings, however, were on my arrival at once commenced, and everything was done to hasten her completion, but she was not out of the hands of the dockyard until 1st April. The "*Guide*" had been reported by the Marine Department as ready for sea some time previously, and was turned over to this Department as equipped and ready for service.

On again looking over the schooner "*Lady Lawrence*," it became apparent that she could not carry a steam-cutter, and, as her accommodation for chart work was very limited, I considered it unadvisable to fit her for service under this Department and addressed the Government, proposing, on the above grounds, that she should be re-transferred to the Marine Department.

19. On the 20th February 1875, three Naval Officers, *viz.*, Lieutenants Jarrad and Hammond and Sub-Lieutenant George, together with Mr. R. C. Carrington, arrived and took up their appointments, the remaining Naval Officers, Navigating Lieutenant Oghlan and Sub-Lieutenant Petley, arriving in the course of the following month. Three Officers of the Bengal Marine and Hooghly River Survey, respectively, had been previously appointed in India on probation.

Appointments taken up.

20. Pending the opening of the season for active operations at sea, my attention was given to the preparation of a modified scheme, shewing what vessels and establishments were exactly required for the Department, and the duties which we proposed to undertake. On these proposals the Government of India, after some delay, passed orders on the 25th October 1875.

Resolution, defining the duties of the Department and ratifying appointments.

By that Resolution the appointments of the Superior Officers were formally recognised and notified, a suitable office establishment was sanctioned, and the duties of the Department defined as follows:—

a.—That systematic surveys of the coast of India were to be undertaken in suitable vessels, efficiently equipped and manned. The Superintendent of Marine Surveys acting in concert with the Surveyor-General of India, and arranging that the Marine Surveys should be connected with those of the Great Trigonometrical Survey.

b.—The original surveys of ports, harbours and river entrances, when received in the Office of the Superintendent, were, after approval, to be photozincographed at the Surveyor-General's office, and issued for local navigation and engineering purposes. From these, as well as other surveys of the coast, executed on a smaller scale, charts of the coast were to be compiled on a medium scale for general navigation.

c.—Copies of all original surveys to be forwarded to the Hydrographer to the Admiralty for publication, on such scales as might be decided on after the consideration of the subject by the Superintendent and Hydrographer. All corrections of surveys and other information connected with them, such as notices of changes in buoys, beacons, lights, &c., to be transmitted at once to the Hydrographer and other naval authorities, to be hereafter arranged.

d.—The Department also to be responsible for maintaining a sufficient stock of the various charts, published by the authority of the Admiralty, and for supplying them to the Local Governments, Officials, or to other persons, in a manner to be arranged hereafter.

e.—In order to carry out these duties effectually, the Local Governments and Administrations, and the Masters-Attendant at the several ports, were directed to promptly communicate all information regarding wrecks, lights, buoys, beacons, or other matters relating to navigation to the Superintendent. The Admiral Commanding Her Majesty's Naval Forces on the East India Station was also requested to furnish the Department with extracts, bearing on the same subject from the remark books of the Officers commanding or navigating any of Her Majesty's ships in Indian waters. The Superintendent of Marine under the Government of Bombay and the Master-Attendant, Bengal, were also instructed to furnish information of a like character which might be reported by the Officers commanding vessels in the Bengal and Bombay Marine. The Superintendent of Marine Surveys was directed to communicate with the Government of India in regard to the lighting and marking of the sea approaches to all great Indian ports and rivers, and to suggest improvements which he might think desirable in harbour conservancy, as well as those required in the navigation of rivers throughout India which might come to his notice, either in the prosecution of the surveys or through local authorities.

f.—The annual wreck chart to be compiled, an annual list of lights issued, and sailing directions for the Indian coasts, hydrographic notices and notices to mariners.

21. Pending the receipt of these orders, the office was being fitted up with all the necessary equipment peculiar to such an establishment as a Marine Survey Office. Under the able supervision of Mr. Carrington, the Drawing Branch was soon in working order, although our staff of subordinates was not completed until very lately. The plans for the drawing tables and presses in which to shelve the published charts of each locality as well as original documents were prepared, and both were soon ready. Mr. Carrington at once set about examining and preparing a catalogue of the numerous original documents which had been brought out from the Admiralty, as well as a selection from those (nearly 3,000 in number) which I had rescued from Bombay. He also prepared a separate catalogue of the published Admiralty charts which were arranged in our presses ready for issue.

The necessary duty of establishing an office routine, systematically filing, docketing, and registering correspondence, starting the books in which to check and audit the accounts of the vessels, preparing necessary forms, as well as assisting me in the many reports called for at this early stage by the Government of India, was undertaken by Lieutenant Jarrad. A suitable Head Clerk was not obtained until November 1875, but the Assistant Clerk and writers were sufficiently acquainted with their several duties by the end of September to then enable me to relieve Lieutenant Jarrad of these duties.

Mr. Donald Sunder, as Head Clerk and Accountant, since November 1875, has rendered good service in my office, and I cannot speak too highly of his intelligence, assiduity and devotion to his duties.

22. The official correspondence during the year 1875 was rather heavy, considering the small office staff which, during the greater part of the time, consisted only of one clerk and one copyist. The number of official letters, besides lengthy reports, issued amounted to 356, and

there were 310 demi-official letters and office memoranda sent out up to the 31st December 1875. The large amount of work at the commencement was consequent on settling and placing all details before the Government prior to the issue of the Resolution, which, in consequence of questions raised by the Military (Marine) Department, and which had previously been considered as settled in England, was delayed until 25th October 1875. In consequence of this protracted delay, the greatest difficulty was experienced in conducting business, as the Accountant-General refused to make any payments either to Officers or crews of vessels without special sanction of the Government month after month. It thus became necessary to make application for each item of expenditure, and this caused serious inconvenience and entailed much correspondence.

23. A large number of nautical questions of a scientific character are from time to time forwarded to me by the Government of India for report. The important nature of some of these subjects, affecting, as they do, so materially the interests of navigators and ship-owners, warrants my enumerating the principal heads for report as being points to which my attention, as well as that of Staff Commander Ellis, has been particularly directed, and the careful consideration of which has occupied a considerable portion of my time.

The most important subjects are as follows :—

Lights	...	{	Necessity for a light on Cape Guardafui.
			" " " Cape Comorin.
			" " " Muttum Point.
			" " " Minicoy Island.
			Necessity for removal of Coringa (Hope Island) light to a more suitable position.
			The best means of efficiently lighting Cocanada port.
			Lighting the River Hughli.
			Removal or retention of Mutlah light.
			Lights on coast of Burma.

Buoyage and re-survey of Bombay Harbour.

Re-organization of River Hughli Survey.

Re-organization of River Hughli Pilot Service.

Establishment of a permanent Board for the examination of seamanship and of navigation of Masters and Mates in the Mercantile Marine.

The necessity for coolie ships calling at St. Helena and the Cape.

Native Passenger Act of 1876 with reference to long and short voyages, and seasons of fair and foul weather.

Measurements for tonnage of vessels.

Rules affecting emigrant ships. (For the better provision against fire.)

Survey on unseaworthy ships. (Home Regulations.)

I was also directed to prepare an elaborate tabular statement shewing the cost of erection and maintenance of all the light-houses and light-vessels of British India, together with their positions, distinctive characteristics, &c. This duty was assigned to Staff Commander Ellis; the difficulty of getting accurate information has been most astonishing, and has much delayed the completion of this important work.

24. Under the orders of the Government of India, the question of the supply of charts corrected to latest date to Government vessels, marine authorities or other officials requiring them, as also the means of establishing a chart agency where *correct* charts and sailing

directions could be purchased by the Mercantile Marine or others, was fully considered; the necessary forms were prepared to be forwarded to the authorities with whom charts were at present deposited, to enable me to form an idea of the number and date of last correction of those in hand, and also the probable number wanted to meet immediate requirements, and I submitted a proposal to the Government, which, if carried out, will secure the supply of charts containing the latest information to Government officials, and also prevent the nautical public being subjected to the necessity of paying extravagant prices in the bazars for obsolete charts, or being supplied by the Marine authorities with the same description of chart, from a stock which had been allowed to accumulate for years without correction.

25. The proposal (commended by the Department of Commerce, which knew well the local exigencies of India as indicated by enquiries into many a wreck) was sanctioned by the Government of India, but the Admiralty (presumably at the instance of their Hydrographer) have lately expressed their dissent generally to any chart office being established in Calcutta.

26. This is much to be regretted, as it has delayed the execution of this most important duty of our department, the Admiralty having withheld the charts which were demanded to meet the requirements of India. The subject, however, I trust will be placed before their Lordships in such a light as to convince them of the urgent necessity to reform the method hitherto pursued, and which has proved so disastrous in India.

27. A depôt for the sale of charts in Calcutta, under the control of this department, will ensure the latest editions being at all times procurable. The want of this is daily felt, and numerous applications are made for charts, sailing directions, &c., which have been met as far as our limited stock would permit us. Amongst these applications I may mention that large demands from the Admiral Commanding Her Majesty's Flying Squadron proceeding to China and Her Majesty's troop-ship *Himalaya* were complied with.

28. All arrangements have been made for the correction, supply and sale of the charts, and we only now await their Lordships' consent to supplying us with a sufficient number of copies, the originals of which were executed by Indian surveyors, paid for from Indian revenues, and the copper-plates of which, though stored at the Admiralty, are the property of the Indian Government.

29. The wreck chart shewing the position of wrecks and casualties which occur during the year in Indian waters will, after the 1st April 1876, be prepared in the Drawing Branch, as well as a detailed statement and review. All the correspondence necessary for gathering every particular of accidents and disasters to shipping, as well as the issue of notices of the same to the Board of Trade, other authorities and public prints, is now carried on in that branch of this Department.

30. The season had so far advanced, on the arrival of the officers and the completion of the vessels, as not to admit of any extensive operation being commenced. Most of the officers were ordered to rendezvous at Calcutta, so that the *Clyde* and *Constance* at Bombay could not be despatched with an efficient staff. Under these circumstances the work allotted to each was, of necessity, limited to the time and means at the disposal of the Officer in Command.

Employment of vessels during the early part of 1875.

31. Staff Commander Ellis in the *Clyde* was instructed to render every assistance to Mr. A. O. Hume, C.B., Secretary to the Government of India, in the Department of Revenue, Agriculture and Commerce, who took a passage on board for the purpose of visiting various proposed sites for light-houses. A visit to Minikoy was originally contemplated, but it was doubtful whether the *Clyde* could carry coal enough to bring her back from that island against the N.-E. Monsoon. Leaving the coast of India about Pigeon or Hog Island, he was to measure a meridian distance to one of the islands of the Laccadive group, among which he was to remain about a fortnight, testing the accuracy of the existing charts and making any necessary additions to them. Leaving the Laccadives, Staff Commander Ellis was to proceed to Paumben to meet the *Constance*; and, passing through the Paumben Pass, to examine the anchorage, and also test the soundings between the Shingle islets and Ramesaram; after which he was to leave for Calcutta by 10th March.

The "Clyde."

32. Mr. Chapman in the *Constance* (see para. 16) was first to proceed to Kolachel to make a survey of the anchorage on a scale of 10 inches to the nautic mile, also a small plan of Enciam islet and rocks, after completing which he was to proceed through the Paumben Pass into Palk Straits. Here he was to obtain additional soundings, and, after noting the effect of the burst of the monsoon in the neighbourhood of

The "Constance."

Paumben Pass, leave for Cocanada. On arriving at Cocanada he was to commence a plan of that port, continuing to work in the southern portion of the Bay of Coringa until relieved by an Admiralty surveyor. On the 20th June I sent Lieutenant Hammond, R.N., to take command of the *Constance* and charge of the survey, relieving Mr. Chapman, who returned to Calcutta to prepare his fair sheets. Sub-Lieutenant Petley, R.N., also was attached to the *Constance*, and proceeded with Lieutenant Hammond to Cocanada by mail steamer.

33. The *Guide* was not ready until 7th April. I was thus obliged to relinquish my first idea of sending her to survey the Megna Flat, or even False Point, as only one of the iron steam-cutters built in Kidderpore yard was ready, and those built in England had not yet

The "*Guide*."

arrived. I therefore determined that, with the view of testing her equipment, as well as for the purpose of ascertaining the qualifications of the officers who had been appointed in India to the subordinate grades in the survey, the *Guide* should proceed down the river in charge of Navigating Lieutenant Coghlan, R.N., and as a preliminary experiment, survey the dangerous *James* and *Mary* shoals, of which we possessed no scientific examination.

34. The *Clyde* arrived in Calcutta on the 2nd April, and Staff Commander Ellis, R.N., reported that he had been obliged to sail the vessel during the whole of the voyage, as, shortly after leaving Bombay, the engines had broken down, and they were obliged to make the passage entirely under sail, never being able to start the engines. He also reported so unfavourably on the *Clyde's* sailing qualities, and on her suitability as a surveying vessel, that I applied to the Government to appoint a Board of Officers to hold a survey on her. In the meantime she was placed in the hands of the dockyard authorities, and the defect in the engine examined. On the 7th and 14th May 1875, respectively, a Committee composed of the Officers marginally noted held a survey on the vessel, but the report of the Committee was never officially communicated to me.

Surveys on, and changes in, materiel.

Master-Attendant.
Staff Commander Ellis, R.N.
Nav.-Lieutenant Jarrad, R.N.

Survey on the "*Guide*."

35. On the 24th May the *Guide* returned, having completed the work detailed in my instructions to Lieutenant Coghlan. During the progress of the survey one of the iron steam-cutters built in Kidderpore dockyard foundered and could not be recovered. From Lieutenant Coghlan's report of this accident it appeared that these boats were unsuited for sea work and only safe in the smoothest water. In accordance with my instructions, Lieutenant Coghlan forwarded a report on the capabilities and suitability of the *Guide* for surveying service, &c. This report contained numerous complaints against the material supplied, and an opinion that the vessel was in every way unsuited for the work; I, therefore, forwarded a copy of his report to the Government of India, asking that a Committee might be appointed to survey the vessel and enquire into the correctness of the statements made in the report. On this representation the

Staff Commander Ellis, R.N.
Nav.-Lieutenant Jarrad, R.N.
C. Ransom, Esq., Commanding I. G.
Steamer *Celerity*.
J. Cranstoun, Esq., Builder, Dockyard.

Government appointed the Officers marginally noted to hold a survey on the *Guide*. The result of the enquiry was that, after completely opening out the vessel, she was found to be so affected by dry rot that the Committee condemned her as unseaworthy, and they were of opinion that the vessel was so defective as to render it inadvisable to incur expenditure in repairs. It was certainly the duty of the dockyard officials, when they received the order to prepare and fit up the *Guide* for surveying service, to have first ascertained that she was in sound condition. It appears, however, that no steps were then taken to ascertain this important fact; but it subsequently transpired that a Committee had, about two years previously, reported that the *Guide* would be fit for any service after undergoing a few necessary repairs.

36. By order of the Government of India the brig *Guide* and schooner *Lady Lawrence* (see para. 18) were re-transferred to the Marine Department on the 15th January 1876.

37. Consequent on the above changes a reduction in the establishment of the executive officers became necessary. The services of Mr. D. B. King and Mr. W. Norman were dispensed with, and Mr. J. B. Morgan left at his own request on urgent private affairs.

Changes in personnel.

38. Navigating Lieutenant Coghlan, Deputy Superintendent, 2nd Grade, resigned his appointment on the 13th July 1875 and proceeded to England.

39. On the 30th August 1875 the programme of operations for the season of 1875-76 was submitted to Government,* and it was asked that instructions might at once be given to the dockyard authorities to prepare the *Clyde* for service so as to enable her to start on the 1st November.

Operations for 1875-76.

It was not, however, until the 9th October 1875 that any intimation was given to this department that the defects of the *Clyde* would be made good. The next day was the first day of the Doorga Puja holidays; the dockyard was closed until the 18th October, and work not commenced until the following day.

40. The above delay seriously affected the preparations, and it was not until the 13th November that the vessel was ready for sea, although every means had been taken in this department to expedite her departure. I feel it my duty to state that the continued delay in the issue of a Resolution ratifying the appointments made in England by the Secretary of State, and defining the duties of the department, caused my movements, towards making the necessary arrangements for the proper conducting of the survey, to be so impeded as to render my position a most vexatious one. I may add that it was not until the issue of the Resolution on the 25th October that my proposals, even in the most trifling details, could be carried out effectively. Until that date none of the public offices recognised the existence of the department, and the inconvenience caused by this was especially felt in conducting business with the Account and Marine Authorities. It was not, therefore, until 25th October 1875, more than fifteen months after my appointment, that I was *really* able to carry on the duties of the department. The delay in the Marine Department passing orders on the *Clyde* is much to be regretted, as by this means nearly three weeks of the fine season were lost; whilst in the case of the *Constance* there was a loss of five weeks.

Delay in commencing out-door work.

41. On the receipt of the Resolution, Captain Ellis took up the duties of Chief Naval Assistant, and the other Officers were divided into two parties and attached to the *Clyde* and *Constance*, the former under the command of Navigating Lieutenant F. W. Jarrad, R.N., and the latter under the command of Navigating Lieutenant G. C. Hammond, R.N.

Parties formed.

42. On the 4th October 1875, in accordance with the orders of the Government in the Department of Revenue, Agriculture and Commerce, conveyed in their letter No. 251, dated 20th August 1875, I embarked on board the British India Steam Navigation Company's steamer *Mahratta* on a tour of inspection of the principal ports of Burma. I visited Chittagong, Akyab, Kyauk Phyou, Bassein, Rangoon and Moulmein, returning to Calcutta on the 28th October. During my absence Staff Commander Ellis, R.N., Deputy Superintendent, remained in charge of the office.

Visit of inspection to Burma ports.

43. From this visit of inspection I came to the conclusion that the charts of the coast of Burma were even less trustworthy than stated in my "Review of Admiralty Charts." But their deficiencies and errors are traceable mainly to this cause, *viz.*, that, although within

Admiralty charts of Burma Coast.

* The programme was subsequently modified, consequent on the *Guide* being condemned.

the last decade fresh surveys of some rivers and ports have been executed, no copies of these were sent to England owing mainly to the prevalent supposition among Marine officials that it was nobody's business to send them. Thus the charts used by the shipping, and even at the offices of the several Masters-Attendant, did not indicate the actual positions of the buoys which mark the approaches to three or four great ports. Errors in the charts, therefore, should not be attributed to defective Admiralty superintendence in England, but to apparent ignorance or apathy and neglect on the part of successive officials in the Indian Marine Department.

44. The urgent necessity for providing a vessel of suitable construction, properly equipped and fitted for surveying, has become still more apparent since operations have been conducted in the *Clyde*, the only vessel now at our disposal. The reports of Staff Commander Ellis, the committee ordered to survey her, and the officer conducting the survey on the Burma coast last year, all point to the unsatisfactory nature of the capabilities and accommodation of this vessel for the special and important duties for which she is required. All these disadvantages and the economy as well as efficiency to be derived from having a suitable vessel have been the subject of frequent correspondence during the past year.

45. The several ports of British India which are within convenient distance of head-quarters, and which afford special facilities for frequently replenishing coal and stores, will, after the coming season (1876-77), I trust, have all been re-surveyed, and I shall be unable to utilize the *Clyde* on more distant coasts except at a great disadvantage. I am, therefore, in hopes that the construction of the new steamer, sanction for which was granted by the Government of India last summer, will be pushed forward with all practicable despatch, and that, if possible, she may be ready for the season of 1877-78.

46. Mr. M. Chapman, Assistant Superintendent, 2nd grade, and Mr. P. J. Falle, Assistant Superintendent, 3rd grade, were specially brought to my notice by Lieutenant Jarrad, as officers deserving of advancement, and as there were vacancies in the department, I recommended their promotion to higher grades.

47. I cannot close this section of my report without putting on record the most valuable assistance rendered to me by the officers of my department in organizing an office based on the long-tried and well-working system which has made the British Hydrographic Office so famous throughout the world.

48. On the 31st March 1876 the strength of the Marine Survey Department was as follows :—

SUPERINTENDENT'S OFFICE.

Superintendent of Marine Surveys	...	Commander A. Dundas Taylor, I.N., F.R.G.S.
Deputy Superintendent, 1st Grade	...	Staff Commander J. H. Ellis, R.N.
Head Clerk and Accountant	...	Mr. Donald Sunder.
Clerk	...	Preonath Mookerjee.
Copyists	...	{Essen Chunder Das. Bidhoo Bhushan Dey.

DRAWING BRANCH.

Superintendent	...	Robert C. Carrington, Esq.
Chief Draftsman	...	Kally Das Seal.
Draftsman	...	Abdool Kurreem.
"	...	Thomas Rebeiro.
"	...	Abdoor Ruheem.
Chart Clerk	...	Jodoo Nath Das.

One chart mounter, one duftry, one duffadar, 4 peons, and two menials.

EXECUTIVE STAFF OF SCIENTIFIC OFFICERS.

Navigating Lieutenant F. W. Jarrad, R. N.	Deputy Superintendent, 2nd Grade, Command- ing I. G. S. <i>Clyde</i> .
Navigating Lieutenant G. C. Ham- mond, R. N.	Asst. Supdt., 1st Grade, Commanding I. G. S. <i>Constance</i> .
(Vacant)	Asst. Supdt., 1st Grade.
Navigating Sub-Lieutenant E. W. Pet- ley, R. N.	Asst. Supdt., 2nd Grade, attached to I. G. S. <i>Constance</i> .
Mr. Morris Chapman, I. N.	Asst. Supdt., 2nd Grade, attached to I. G. S. <i>Clyde</i> .
(Vacant)	Asst. Supdt., 2nd Grade.
(Vacant)	Ditto.
Mr. P. J. Falle	Ditto, 3rd Grade, attached to I. G. S. <i>Clyde</i> .
(Vacant)	Asst. Supdt., 3rd Grade.

SURGEON AND NATURALIST.

Dr. J. Armstrong, B.A.	Attached to I. G. S. <i>Clyde</i> .
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EXECUTIVE OFFICERS.

Mr. G. W. Hill	Attached to I. G. S. <i>Clyde</i> .
Mr. T. H. Baker	Attached to I. G. S. <i>Constance</i> .

A. DUNDAS TAYLOR,

*Commander (late I. N.),
Superintendent of Marine Surveys.*

SECTION II

DRAWING BRANCH.

Statement shewing the nature of the work performed in the Drawing Branch from May 1875 to 31st March 1876.

This branch, under the superintendence of Mr. R. C. Carrington, has been busily engaged in the production of new navigating sheets of the Coast of India, comprising the whole series from Karachi to Pulo Penang. Five D. E. (*double elephant*) sheets have been compiled and forwarded to the Secretary of State, and they are now in course of being engraved. Several new Charts of Ports and Anchorages, much needed, have also been prepared and photozincographed, as detailed in the following tables:—

No. of Chart.	Title.	Size.	Scale.	REMARKS.
	SHEET 1.			
15	Karachi to Pigeon Island, in Lat. 14° S.	D. E.	3·2 inches = 1 degree.	Compiled from the surveys of Commanders Ethersey, Grieve, Taylor, &c. The Kattywar Coast has been reduced from the original chart discovered by Captain Taylor at Bombay, and shows details never before published; the whole coast has been adapted to the latest astronomical positions in connection with the Great Trigonometrical Survey, and other information regarding lights, &c., corrected to date of publication.
	SHEET 2.			
15a	Vingorla to Cocanada ...	2 D. E.	3·2 inches = 1 degree.	The portion of the coast, between Vingorla on the west, to Cocanada on the east, is embraced in this chart, to be published on two double-elephant sheets. It is intended that these two sheets should be joined to form one good navigating chart of the southern portion of India and the Island of Ceylon. The coast has been most carefully reduced from the large scale Admiralty Charts, and the interior, showing the principal mountain ranges and river courses, as well as all the railways branching from Madras, has been taken from the latest impressions of the " <i>Atlas of India</i> " Sheets. The interior of the Island of Ceylon has been reduced from the excellent large scale map by Arrowsmith, and other notes added from Sir James Emerson Tennent's " <i>Ceylon</i> ." All the latest hydrographic information has been inserted, the whole being adapted to the latest astronomical determinations.
	SHEET 3.			
15b	Cocanada to Bassein River. ...	D. E.	3·2 inches = 1 degree.	Embraces the northern portion of the Bay of Bengal from Cocanada to Bassein River, and includes the whole of the delta of the Ganges. The principal hill ranges, and other details of Aracan and Pegu, have been taken from the Revenue Survey maps of those provinces, and adapted to the latest observations determined by the Hydrographic Surveyors of the Indian and Royal Navies.

No. of Chart.	Title.	Size.	Scale.	REMARKS.
	SHEET 4.			
15c	Bassein River to Pulo Penang ...	D. E.	3·2 inches =1 degree.	Embraces the coast between Bassein River and Pulo Penang, and includes the Andaman and Nicobar Islands. In the compilation of this sheet it was discovered that the difference of longitude, as shown on the Admiralty Charts between Rangoon and Amherst, could not be correct, as the whole of the coast of Tenasserim, &c., between Moulmain and Penang was, by accepting this, thrown upwards of 4 miles too far west. As this was a most important matter to be settled, a meridian distance was measured between Rangoon and Amherst (the entrance to Moulmain River). The positions of the town of Rangoon and Elephant Point Pagoda were determined in connection with the Great Trigonometrical Survey, and forwarded to this Department by Colonel Walker. The result of the meridian distance, applied to these positions, showed that the longitude of Amherst has hitherto been incorrectly shown on the Admiralty Charts. The new position agreed exactly with the work brought up from Penang in connection with Singapore. The delta of the Irrawaddy, as also the interior of Tenasserim and Tavoy, as far south as the Pakchan River, has been reduced from the Revenue Survey maps; the Nicobar and Andaman Islands from the latest corrected Admiralty Charts.
	[NOTE.—The above series of sheets are being engraved in England.]			
474z.d.	Kattiawar coast, by Lieutenant A. M. Grieve, I. N., brig <i>Paliurus</i> , 1854.	2 D.E.	M=0·5	100 copies photozincographed.
117	Luff Point to Anchoring Creek, showing the James and Mary Shoals, and the entrance to the Roonarain, River Hooghly, from the Survey by Navigating Lieutenant J. E. Coghlan, R.N.	Atlas	M=6·0	300 copies photozincographed. The sheet was much needed by local Pilots and Engineers, and can be always used as a reference sheet, being sectionally sounded.
61	Cherbaniani Reef, Chitlac and Kiltan Islands, Lakadivh Archipelago, from the Surveys by Lieutenants Selby and Taylor, late I. N., brig <i>Taytes</i> , 1848.	Small Atlas.	M=2·0	150 copies photozincographed. Re-produced as a record of the Survey.
81	Kolachel Roadstead and Enciam Rocks, Travankor, from the Survey by M. Chapman, late I. N., I. G. schooner <i>Constance</i> , 1875.	Atlas	M=10·0	300 copies photozincographed. Hitherto no plan has existed of this Coffee Port; was also much needed by the Commanders of the B. I. S. N. Company's steamers.
53	Byramgore Reef and Chereapani Lakadivh Archipelago, and Angria Bank, from the Surveys by Lieutenants Selby and Taylor, late I. N., 1847-48.	Atlas	M=2·0 M=2·5	150 copies photozincographed. Re-produced as a record of the Survey.
113	Coringa or Cocanada Bay and the mouths of the Godavery, Bay of Bengal, from the Survey by Navigating Lieutenant G. C. Hammond, R.N.	D.E.	M=2·0	500 copies photozincographed. This is a most important sheet, as the old chart was misleading in the extreme.
851	Quilon Roads, west coast of India, from a sketch by Lieutenant A. D. Taylor, late I. N., 1858.	D.E. 4	M=2·0	200 copies photozincographed. Published at the request of the Commanders of the B. I. S. N. Company's steamers.
109	False Point anchorage, coast of Orissa, from the Survey by H. A. Harris, Conservator of Orissa Ports.	D.E. 4	M=1·5	100 copies photozincographed. Published at the request of the Commissioner of Orissa, as a temporary chart, until the new Survey by Lieutenant Hammond, R.N., can be produced.
39	Entrance to Rajpuri River, west coast of India, compilation from a sketch by Navigating Lieutenant W. P. Haynes, R.N., and Surveys by officers of the late Indian Navy, 1876.	D.E.	M=4·0	200 copies photozincographed. Published, as there was no existing plan of the anchorage.
	Index Chart of light-houses and light vessels in British India.	D.E. 4		150 copies photozincographed. Bound up with the new Light List.
	Magnetic chart of the Indian Ocean			In course of preparation.

Miscellaneous.	For what purpose executed.
Reduction of False Point Anchorage for comparison with Admiralty Chart	For office use.
Tracing of Arrowsmith's map of Ceylon	Ditto.
Copy of Kopah Inlet, Siam Coast	For the Hydrographer to the Admiralty.
Tracing of Mr. Harris's Survey of False Point	For Lieutenant Hammond, R.N.
Inserting fathom lines and coast line on 50 sheets of Bahrein Harbour	For issue and sale.
Reduction of Heathcote's Survey of entrance to the River Hooghly for comparison with Admiralty Chart	For office use.
Compilation of the River Hooghly and its approaches	For the use of the Committee enquiring into the River Survey Department.
Copy of Rangoon Approaches, by Lieutenant Jarrad, R.N., 1876	For transmission to the Hydrographer to the Admiralty.
Numerous tracings, corrections and additions to several charts	For the Hydrographer and other Naval Authorities.

Charts corrected.

During the year, 1,091 charts have been examined and corrected for new lights, buoys, shoals, beacons, &c., and the following hydrographic Notices to Mariners attended to, and the charts corrected accordingly :—

	Notices to mariners, affecting 198 Charts.
244 English	
364 American	" " " 37 "
17 Indian Government	" " " 116 "
188 Spanish	" " " 47 "
511 Dutch	" " " 59 "
167 German	" " " 72 "

New Publications.

A list of light-houses and light-vessels in British India, with an index chart shewing the position of the various lights.

A Catalogue of Charts for 1876.

Spheroidal tables,—showing the length in feet of a degree, minute, and second of latitude and longitude; the corresponding number of statute miles in each degree of latitude; the number of minutes of latitude, or nautic miles, contained in a degree of longitude, under each parallel of latitude; and the length, in cables, of a minute of longitude, corresponding to each nautic mile,—for every ten minutes of the quadrant, compression $\frac{1}{16}$,—by R. C. Carrington.

SECTION III.

SURVEYING OPERATIONS.

(EARLY PART OF 1875.)

TRAVANCORE AND GULF OF MANAR.

(I. G. SCHOONER *CONSTANCE*.)

THE *Constance*, with staff as per margin, left Bombay on the 29th January 1875, and arrived at Kolachel on the 7th February. The staff was only a temporary one, as there were no other naval surveyors available, and Mr. Chapman, who was the only surveyor on board, was consequently working really alone; he, however, reports that the executive officers shewed a desire to acquire a knowledge of surveying, and were of some assistance to him in this survey.

Personnel.
Mr. M. Chapman, late I. N.,
Officiating Assistant Superintendent, 1st grade,
Mr. Hill, Executive Officer.
" Baker,
" Searle, Surveying Ammanensis.

} Commanding.

Work was commenced on the 8th February. The survey was executed more in the style of a land survey, as Mr. Chapman's knowledge was gained under Mr. Girdlestone (late I. N.) of the Topographical Survey of India, who for a time was lent to command the *Constance* for the purpose of surveying Bahrein in the Persian Gulf. The coast was charted by means of a traverse survey with theodolite, chain and plane table, and the soundings were not obtained in sections, but Mr. Chapman made a plan of the port which, to all intents and purposes, suffices for the requirements of navigation. The amount of coast charted was 6 miles, and 5½ square miles of water were examined.

The *Constance* left Kolachel, and, touching at Tuticorin for water, proceeded through the Paumben Pass to Paumben. During the month of April Mr. Chapman was working in Palk Strait, obtaining additional soundings and verifying those on the published charts. After noting the burst of the southwest monsoon from Condigal Point, the *Constance* left on the 16th May, and, after touching at Madras, arrived at Cocanada on the 23rd May.

Soundings in Palk Strait and Gulf of Manar.

The survey of Cocanada was at once commenced by Mr. Chapman, and he carried on the work in the southern portion of the bay until relieved by Lieutenant Hammond, R.N., on the 21st June, when he returned to Calcutta. From that date the survey was carried on by Lieutenant Hammond assisted by Sub-Lieutenant Petley, and was completed on the 24th August. The survey comprised 79 square miles of water and 42 miles of coast charted on a scale of 2 inches = 1 nautic mile. Lieutenant Hammond furnished a lengthy report on the question of effectively lighting the port of Cocanada, which was forwarded to the Government for consideration. On the 12th September the *Constance* arrived in Calcutta.

Cocanada Survey.

RIVER HOOGHLY.

(I. G. BRIG *GUIDE*.)

On the 8th April, the *Guide*, with staff named in the margin, proceeded down the river and anchored off Roychuck, in the vicinity of the James and Mary Shoals. The plan of this dangerous part of the Hughli, Luff Point to Anchoring Creek, including the entrance to the Roopnarain river, was constructed on 10 inches to the nautic mile, the river within these limits being sounded in sections which in no case were more than 400 feet apart. The work was completed on the 24th May, when the *Guide* returned to Calcutta, and Sub-Lieutenant George commenced preparing the fair sheet, which was afterwards reduced and photozincographed on a scale of 6 inches to the nautic mile. It is a valuable chart for record, and, if the whole of the river from Chandernagore to the sea were similarly surveyed from year to year, the comparison of these minute surveys, and the knowledge of the action of the tides and freshets on particular localities, which such a rigorous survey would impart, would enable engineering works for the improvement of the conservancy of the river to be carried out with confidence as to their results.

Personnel.

Navigating Lieutenant J. E. Coghlan, R.N., Deputy Superintendent, } Commanding.
 Navigating Lieutenant G. C. Hammond, R.N., Assistant Superintendent, 1st grade.
 Sub-Lieutenant C. George, R.N., Assistant Superintendent, 2nd grade.
 Sub-Lieutenant E. W. Petley, R.N., Assistant Superintendent, 2nd grade.
 Mr. J. Nickels, Assistant Superintendent, 2nd grade.
 Mr. P. J. Falle, Assistant Superintendent, 3rd grade.
 Mr. C. J. Wortley, Assistant Superintendent, 3rd grade.

SOUTHERN INDIA AND LACCADIVE ISLANDS.

(I. G. S. *CLYDE*, 300 TONS, 60 H. P.)

Staff-Commander Ellis, R.N., with officers named in the margin, proceeded on the 2nd February in the *Clyde* for Calcutta, the head-quarters of the Marine Survey Department, taking as passenger Mr.

Personnel.

Mr. J. B. Morgan, } Executive Officers.
 " D. B. King, }
 Dr. J. Armstrong, Surgeon and Naturalist.

A. O. Hume, C.B., Secretary to the Government of India, Department of Revenue, Agriculture and Commerce, as important questions concerning light-houses, commerce and navigation had to be considered by him.

The *Clyde* finally left Bombay for Pigeon Island, calling *en route* at Vingorla rocks and St. George's islands. During this short trip the engines broke down entirely, in consequence of several portions of the machinery becoming disabled, and further by the jamming of the screw shaft in the stern post aperture. Thence to Calcutta the voyage was performed under sail alone.

Having secured the necessary chronometrical and astronomical observations at Pigeon Island for connecting by meridian distance* this island with one of the Laccadive group, sail was made on the 8th February for Cherbaniani, and whilst proceeding thither several deep soundings were obtained.

Laccadive Islands.

Cherbaniani, the northernmost dangerous reef of the group, was reached on the 11th, and anchorage obtained in 8 fathoms about 200 yards from its south-west edge. From the observations and exploration made, no change in the shape or extent of the reef had occurred since the survey by Lieutenants Selby and Taylor in 1848. The *sandbanks* mentioned in the west coast of Hindoostan Pilot as situated on its north and east side, proved to be heaps of decayed coral.

Betra-par, to the southward, was the next reef visited, and astronomical observations obtained on Tree island situated at its northern extremity. Mr. Morgan, who explored this reef, informed Commander Ellis that the sandy islet stated in the Sailing Directory to lie to the eastward of the reef, did not exist.

The vessel then visited, in the order mentioned, other islands of the group, *viz.*, Kiltan, Cardamum,—where observations for meridian distance and circum-meridian altitudes for latitude were taken.—Ameni, Pere-mul-par, Aucutta group, Pitie sandbank and Cabruti. These islands and reefs excepting Kiltan, which is well surveyed, are very insufficiently examined, and great caution is necessary when navigating in their vicinity. From the *Clyde*, breakers and several shoal patches were observed, when sailing between Aucutta and the islands Bingaro and Tingaro to the north-east.

* Since forwarded to the Hydrographer of the Admiralty.

Proceeding to Kolachel, where the vessel arrived 27th February, a deep sounding of 990 fathoms was obtained, 19 miles due west of Kalpeni, and 1,290 fathoms in latitude $9^{\circ}38'40''$ N., longitude $74^{\circ}55'40''$ E., the nature of the bottom in neither case being ascertained, owing to the line parting when hauling in. This sounding line, previous to its being supplied to the *Clyde*, had been in store at Bombay Dockyard for upwards of 14 years, and on examination was found to be in a state of great decay.

Leaving Kolachel on 28th February, having taken on board stores, &c., the vessel anchored at Tuticorin outer anchorage (distant about 90 miles from Kolachel) on 8th March, having experienced head winds or a succession of fresh north-east breezes for the first week. This trip afforded Commander Ellis an excellent opportunity for testing the sailing qualities of the *Clyde*, which resulted on arrival at Calcutta in a very unfavourable report. The voyage thus far having been tediously long, Mr. Hume, whose term of leave had nearly expired, decided to land and overtake a steamer at Madras to enable him to resume his public duties at Calcutta on the expiration of his leave, as it was found by continuing on the *Clyde* it would be quite impossible to do so. During a stay of five days the chronometers were rated by observations on Hare island, thus connecting this island with Cardamum of the Laccadives.

On the 15th March, the vessel anchored at Paumben Horse Shoe bank channel, and in accordance with instructions, an examination was made of the depth of the channel into Mootapetta Bay (Port Lorne) and the soundings near that locality were tested, which, on comparison with Captain Powell's survey of 1837, differed considerably. The soundings in the Eastern channel, between the Shingle islets, Cooreesuddy island, and Ramesaram island, were likewise tested, and, although agreeing tolerably well with the former survey, it is desirable that a new survey, when opportunity offers, should be made. The positions of the several conspicuous white beacons which have been erected of late years to facilitate the navigation of Paumben Pass—buoys and other marks—were obtained. The dredging and blasting operations are still continued in the Pass, and a depth (March 1875) of 11 feet 9 inches attained; it being confidently expected that the Pass would soon be available for vessels of 14 feet draught.

The *Clyde* was then taken to a position about $2\frac{1}{2}$ miles off shore to the northward of Ramnad Promontory in latitude $9^{\circ}20'$ N., longitude $79^{\circ}6'$ E., and the distances from high-water line of the 2, 3, 4 and 5-fathom low-water depths were ascertained. It was near this position that the site of a proposed cutting, or ship canal, through Tonitory point, by Sir James Elphinstone, received recently some attention by Mr. George Robertson, a Civil Engineer appointed by the Government of India to report on Indian harbours. He had only time, however, for a very cursory examination; but this, together with several other proposed schemes, has been rejected for the less costly undertaking of deepening, by dredging and blasting operations, the channel formed by nature.

Commander Ellis now decided to push on as fast as possible for Calcutta, as it was impossible for the want of steam, the limited means at his disposal, and being single-handed, to carry out further the several investigations in Palk's bay which I had instructed him to make. He accordingly left Paumben on the 20th March, calling at Madras on the 24th for provisions, &c., and arrived in Calcutta on 2nd April.

During the voyage the dredge was used whenever practicable, and many marine specimens of interest were collected. Some good specimens of sea birds were also collected and preserved, which were of use to Mr. Hume in writing his valuable papers on Indian ornithology.

SURVEYING OPERATIONS

(SEASON, 1875-76.)

BURMA COAST.

(I. G. STEAMER *CLYDE*.)

The *Clyde*, with staff marginally noted, left Calcutta *en route* for Rangoon on the 13th November 1875. When off Cape Negrais the dredge was used as often as practicable, but the locality proved to be too rocky to afford many natural history specimens, and the *Clyde* anchored at Diamond Island on the 20th November to rate the chronometers and allow Dr. Armstrong to explore the reefs which extend one and a half miles from the south point of Diamond Island. Leaving Dia-

Personnel.
Navigating Lieutenant F. W. Jarrad, } Command-
R. N., Deputy Superintendent, } ing.
Navigating Sub-Lieutenant C. George, R. N., As-
sistant Superintendent, 1st grade.
Mr. M. Chapman, I. N., Assistant Superintendent,
2nd grade.
Mr. P. J. Falle, Assistant Superintendent, 3rd grade.
Dr. J. Armstrong, B.A., Surgeon and Naturalist.

mond Island on the 22nd, the *Clyde* arrived at Rangoon on the 24th. Coaling and making the necessary arrangements for the transit of a party for the purpose of erecting stations along the hitherto unmapped shore between Elephant Point and the entrance to the To-Kwa (China Ba-keer) river occupied until the morning of the 28th November, when the vessel proceeded down the river and anchored off Elephant Point. Work was commenced on the 29th November.

Lieutenant Jarrad reported that the erection of a tide-pole in a suitable position was a matter of great difficulty owing to the exposed nature of the only available positions and great strength of the tidal stream, which, acting on the great length of pole necessary to register

Survey of Rangoon.

22 feet rise and fall, caused it frequently to be swept away. Indeed, the tide-pole appears to have been a continued source of anxiety from the frequency in which it was broken off by the above causes, or from native boats fouling it, and thus many days' work was utterly lost. It is most important that a substantial tide-pole should be erected at Elephant Point, so that there would be no delay or difficulty in examining the river at any time. A series of uninterrupted tidal observations at this place would be of great value, and I hope ere long to see a self-registering tide-gauge erected there. The erection of the main stations occupied some time, especially those along the coast between Elephant Point and the China Ba-keer river, where, owing to the great distance the mud banks extended off shore, considerable difficulty was experienced in landing. A party, however, after several ineffectual attempts, at last succeeded in landing the necessary tents and instruments, and, through the kind assistance of Lieutenant Parrott, Assistant Commissioner, who made all the arrangements for the transit of the party, &c., the work was successfully accomplished in four days. Owing to the coast being so low, and in most parts fringed with mangroves to the water's edge, the main stations required to be of some dimensions and also to be constructed in a very substantial manner. Ordinary marks could be but barely discerned at the edge of the mud flats, much less could they be distinguished in the channels where they were required to be seen in order to fix the soundings. Occasional bad weather and high tides rendered it necessary to renew these marks once or twice during the progress of the survey. Unfortunately the nature of the ground (soft mud) prevented any steps being taken towards arranging for permanent stone or brick pillars being placed to mark the sites of the several main stations of the survey. Owing to the strength of the tidal stream during spring tides, the boats were able to do but little sounding at that period, and the operations were then confined to shore work; indeed it might almost be said that the sounding was solely performed during neap tides. During the months of November and December the strong breezes caused a heavy sea on the banks and very much impeded the progress of the work, while the continuous thick fogs in January and February

were the cause of sometimes three or four days at a time being lost. The survey was thus not completed until the 8th March, a month later than was estimated.

The survey of the approaches to Rangoon river comprised $87\frac{1}{2}$ miles of coast trigonometrically laid down, and 216 square miles of water examined; the new chart extending 30 miles north and south and 18 miles east and west. The difficulty of sounding sectionally with the exactitude with which this survey was executed in such strong tides and on a low coast, where marks cannot be made prominent, cannot be over-estimated.

Extent of survey of Rangoon approaches.

In compiling in the Drawing Branch Sheet 4 of the coast series,* Mr. Carrington found that when the coast of Tenasserim was drawn in connection with Singapore and Penang, there existed a gap of about $4\frac{1}{2}$ miles of longitude between the above coast and that inserted

Longitude of Amherst.

from the Admiralty Chart of the Gulf of Martaban, &c.

To clear up this very important point, I telegraphed to Lieutenant Jarrad at Rangoon, and ordered him to make the necessary observations for measuring a meridian distance between Elephant Point (Obelisk), Rangoon river, the position of which had recently been determined by Mr. Beverley of the Great Trigonometrical Survey of India, and Amherst Point (Pagoda), Moulmein river. The meridian distance was measured with 8 chronometers, the errors of which were determined on each occasion by six sets of observations of equal altitudes of the sun's limbs and centre, observed at Elephant Point on the 22nd February and 2nd March, and at Amherst on the 24th and 29th February. The travelling rates deduced from the above observations, when applied, gave the results shown in Appendix H.

The range of the difference in the results of the meridian distances, as shown by each of the 8 chronometers, was 2.25 seconds.

The result was most satisfactory, as it proved the correctness of Captain Ross' triangulation of the coast of Tenasserim in connection with the astronomical positions of Singapore and Penang, and cleared up the discrepancy existing between the position of Amherst, as shown on Sheet 4, in connection with Singapore and the position of the same place as shown on the Admiralty Chart of the Gulf of Martaban, No. 823, by proving that the position, as given on the above-named document, was $4\frac{1}{2}$ miles in error.

Longitude of Elephant Point Obelisk, as determined by Great Trigonometrical Survey	...	...	...	96° 19' 14".2
Meridian distance by Lieutenant Jarrad, R. N.	...	...	...	1° 13' 49".10
Longitude of Amherst Point Pagoda	...	...	...	97° 33' 03".8
Longitude from Admiralty Chart No. 823	...	...	...	97° 28' 30".0
Error in position of Amherst on Admiralty Chart	...	...	...	4' 33".8

Rangoon and Amherst had not previously been connected by a meridian distance, and I consider this to have settled a very important point.

I have determined on having observations made next season at Diamond Island (off Cape Negrais) and Amherst for the same purpose. We should then have three of the principal points in the Gulf of Martaban in their relative astronomical positions. An entire series of meridian distances was one of the principal wants referred to by the Committee, of which Captain Constable was a member, and who reported on the want of Indian Marine Surveys as far back as 1862. The whole of the eastern side of the Bay of Bengal has hitherto been very incorrectly laid down on the Admiralty Charts, an error of from five to eight miles sometimes existing, and no systematic astronomical connection of the principal places along the seaboard has ever been made. As our surveys progress, these errors will be cleared up, as, when a suitable vessel is provided, a chain of rigorously measured meridian distances will form the primary

Want of a series of meridian distances.

* See page 13.

work on each coast; but although we must wait for such a systematic method of procedure from want of suitable means, we can clear up gradually a few of the existing errors in longitude; and this is being done.

The Krishna shoal light had been reported out of position by the Officer Commanding I. G. Steamer *Nemesis*. I therefore instructed Lieutenant Jarrad to test, if time and circumstances permitted him, the correctness or otherwise of this statement on his way from Rangoon to Akyab. This was done, and the result shows that the Krishna Light-house is in the position assigned to it on Admiralty Chart No. 823, and that the report of the above officer was incorrect.

Lieutenant Jarrad also obtained a line of soundings westward of the Krishna light, which, although not sufficient to be called an examination, yet goes to prove that the Baragua Flat has not extended to the southward as reported to the Government by the Officer Commanding the I. G. Steamer *Tenasserim*. Stringent orders should be issued to the Commanders of these vessels to take every opportunity of verifying any suspected discrepancy or error in the charts or sailing directions, of which they have frequent opportunities; and they should also be instructed that, in the event of their discovering any such error, their report should contain a clear and concise statement of the steps which were taken to establish a proof of the correctness of their conjectures; the observations taken should also accompany the statement. Statements of the nature above alluded to, unsupported by any direct proof, are worse than useless: they are mischievous.

It was the intention to have tested the longitude of Diamond Island, but on the *Clyde's* arrival there the weather was so unfavorable that the vessel was obliged to anchor under the lee of the island for shelter. Here she remained for two days, during which time the sea was so heavy as to render landing on the island impracticable.

On the 16th March the weather moderated, and the *Clyde* left for Akyab, sounding at intervals to ascertain if the depth admitted of putting over the dredge. The dredging operations were of necessity limited to shallow water, owing to the lack of the necessary appliances for deep-sea sounding and dredging on board.* The greater number of dredgings were obtained in depths varying from 90 to 10 fathoms to the southward and westward of Cheduba Island, and thence northward towards Akyab, passing the Terrible Rocks at about 7 miles off. This locality proved to be very prolific, and afforded several very beautiful specimens, some of which I believe are entirely new.

The *Clyde* arrived at Akyab on the 20th March, and on the 21st the survey was commenced, and by the end of the month the base had been measured and the main triangulation obtained. Much of the Surveyors' time was spent in superintending parties clearing the tops of the hills of jungle to enable the necessary stations to be erected. On the summit of Borongo the jungle was so high as to necessitate a party staying there two days. Lieutenant Jarrad reports it difficult to obtain Burmese to cut the jungle, as the natives are extremely independent, and demand very high wages. The want of an interpreter, too, was much felt here, as none of the natives understood a word of English or Hindustani, and communication with them was carried on with difficulty.

Cholera had been spreading for some time amongst the native population, especially amongst the coolies employed in the rice-mills, numbers of whom died daily; and there had also been some fatal cases among the shipping and in the prison. On the night of the 30th March, Navigating Sub-Lieutenant C. George, R. N., Assistant Superintendent (1st grade), was suddenly seized with this fatal disease, and although

* The *Clyde* is too small for a sea surveying vessel, and could not be fitted with the necessary gear without great expense, and no adequate return could be expected.

everything was done by Dr. Armstrong (the Surgeon of the *Clyde*) and the Civil Surgeon of Akyab (Dr. Mountjoy) to arrest the progress of the disease, this unfortunate officer died at noon on the 1st April. As some of the officers and crew were suffering from symptoms of a similar character, Lieutenant Jarrad decided, with the concurrence of Dr. Armstrong, that the ship should be vacated by the healthy portion of the crew. This was accordingly done, and a camp was formed on the sea beach in a healthy situation, while both healthy and sick were narrowly watched. The ship was fumigated and thoroughly cleaned in a few days, and fortunately no more cases occurred, and the worst case amongst the sick recovered.

As I was then on my way down the coast of Burmah on a visit of inspection, I saw Lieutenant Jarrad at Akyab, and as cholera was still raging in the district, I ordered Lieutenant Jarrad to suspend his operations, and, with a view of recruiting the health of the officers and crew, leave Akyab for a cruise outside, during which time he was to visit the Terrible Rocks and ascertain on which group a light-house could best be erected in the event of its being found necessary to establish a light there, and he was also to obtain soundings and dredgings as opportunity offered.

The *Clyde* left Akyab on the 10th April, sounding and dredging to the southward towards Cheduba Island, where the vessel anchored. The channel between Cheduba and the mainland of Ramree Island was examined and found to contain very uneven depths, the general features not at all agreeing with the published chart; but the weather was so threatening, and heavy rollers had set in from the south-west, that only a very rough examination could be made, and the anchorage was so exposed that, taking into consideration that bad weather might be expected at any moment, Lieutenant Jarrad thought it unsafe to remain there. The *Clyde* therefore proceeded northwards, and tested the correctness of the coast of Ramree Island between Cheduba and Kyouk Phyou, as delineated on Admiralty Chart No. 821. Lieutenant Jarrad reports it to be very roughly laid down, the character of the coast (high hill ranges) not shown, and the whole to be "out of bearing" * when referred to Cheduba Island. This is to be easily accounted for, as the chart referred to was compiled in the Hydrographic Office from the best material in hand; but as these were more of the nature of sketches than surveys, and as the astronomical positions of the points between which the coast was filled in were never ascertained by any rigorous method, it is more than probable that considerable errors exist in the longitudinal distance between many places (as was the case between Elephant Point and Amherst), and consequently portions of the coast, though charted locally with tolerable correctness, may be relatively very much out of bearing.

Westerly rollers, causing the sea to break heavily, prevented a landing being effected on any of the rocks of the group, and after spending a day in their vicinity, the threatening appearance of the weather made it advisable to seek a safe anchorage in Kyouk Phyou.

The examination of Kyouk Phyou harbour was at once commenced. The necessary stations were erected, and the main triangulation obtained, the buoys fixed, the Bombay and Reliance Shoals examined, and part of the coast and foreshore plotted on a dry proof of the published Admiralty plan of the harbour. This was done for the purpose of ascertaining whether the published plan was sufficiently correct with respect to the shore details, so as to necessitate only a re-examination of the reefs and anchorage. The published plan, however, was found so incorrect that I have arranged for the survey of this harbour to be continued next season, should time admit of this being done.

The fine weather broke up on the coast of Burma about the 15th April, and the *Clyde* left Kyouk Phyou on the 24th, arriving at Calcutta on the 28th, having experienced heavy weather off the Sandheads.

* See p. IX, Appendix F

Considering all the difficulties with which Lieutenant Jarrad has had to contend in this the first season of the resumption of Marine Surveys in India, that he was working with a native crew, and that a great part of his time was necessarily devoted to bringing the members of his staff, who had been gathered from different sources, to work in a uniform and systematic manner, and also that the vessel affords none of the facilities for scientific surveying which are to be met with in a vessel engaged on similar service in the Royal Navy, I think the outturn of work has been satisfactory.

ORISSA COAST.

(L. G. SCHOONER *CONSTANCE*.)

The *Constance*, with the staff detailed in the margin, left Calcutta on 6th December 1875, arriving at False Point on the 9th December, but bad weather prevented Lieutenant Hammond commencing work until the 12th. The base having been measured, the necessary stations erected, and the main triangulation having been obtained, a large scale plan of the anchorage was begun on a scale of 6 inches to a nautic mile. On the 28th, however, the steam-cutter

Personnel.
 Navigating Lieutenant G. C. Hammond, R.N., Assistant Superintendent, 1st grade, Commanding.
 Navigating Sub-Lieutenant E. W. Petley, R.N., Assistant Superintendent, 2nd grade.
 Mr. W. H. W. Searle, Surveying Amanuensis.

broke down, and it was found necessary to haul the boat on the beach for repair; and from this date until the 10th January the work had to be done in pulling boats. On the 8th February the steam-cutter's connecting rod broke, and the boat was again laid up for six weeks, until a new rod could be sent from Calcutta. Owing to these mishaps and the extreme labour required in sounding in pulling boats the work progressed slowly, and it was not until the 9th March that the survey in this locality, detailed in Lieutenant Hammond's instructions, was completed. Besides the 6-inch plan of the anchorage, the coast as far as 5 miles south of False Point Light-house and 10 miles to the north was surveyed on a scale of 3 inches to the nautic mile, the soundings extending to from 5 to 8 miles off shore.

Survey of False Point.

The survey comprised 62 miles of coast trigonometrically laid down, and 120 square miles of water examined.

Lieutenant Hammond, finding that the southerly winds were then so strong as to prevent a survey of the south-eastern part of Palmyras shoal, left for the northern portion of the shoal off the Dhumrah river, where he arrived on the 17th March. A base of 5935.4 feet having been measured on Shortt's tripod sand (the only available dry patch) he commenced the triangulation, putting down buoys seaward and towards Palmyras reef buoy preparatory to sounding the shoals. This occupied a considerable time, as such a heavy sea was running it was found impossible to utilize the steam-cutter, and pulling boats had to be employed; however, 11 lines of soundings, covering about 4 square miles of water, were taken, but unfortunately on the 27th of March, as Lieutenant Hammond informed me in the monthly report of proceedings, a heavy gale had swept away all his sounding buoys, blown down the stations and tide-pole, and completely stopped his working, and that as he was quite unable to do anything he had proceeded inside the Dhumrah river to await orders. He also stated that the greater part of the time was occupied in procuring water, the nearest obtainable being at Chandbally, about 35 miles from the working ground; that a great number of his crew were sick, and in a semi-official letter to Captain Ellis, who was in charge of the office during my absence, stated his inability through ill-health to proceed with the work. He was therefore re-called, and arrived at Calcutta on the 19th April.

Survey of Palmyras shoals.

Considering the many drawbacks Lieutenant Hammond had to contend with, a delay of five weeks in starting, the small staff employed, the difficulties in obtaining trustworthy men, decent food and water, much sickness amongst his crew, the heavy weather encountered, and the extremely rough nature of

the coast, Lieutenant Hammond has turned out a fairly satisfactory season's work.

I am aware of the many disadvantages under which Lieutenant Hammond would labour in a sailing vessel like the *Constance*, but I was not prepared for the series of accidents and impediments reported by him, which, however, appear to have been unavoidable. The outturn of work would always be necessarily small when compared with the cost of keeping up a vessel like the *Constance*. I therefore represented the matter to the Government, asking that the vessel be removed from the Department, as she had proved quite unsuited for surveying service.

Lieutenant Hammond's health on his return necessitated an application from him to appear before a medical board, and he proceeded to England on six months' sick leave.

NATURAL HISTORY RESEARCHES.

Although the time devoted to this branch of the survey was unavoidably short this year, yet I think the results were so far satisfactory, as it has become apparent that when we have a more suitable vessel the Natural History branch will by no means make the least valuable additions to our knowledge of the Indian seas. We have indeed been fortunate in obtaining an officer of Dr. Armstrong's ability and zeal, and I trust, bearing in mind the important additions to science which might confidently be expected from a systematic examination of the *fauna* and *flora* of the Indian coasts and waters, that when arranging the internal fittings of the new surveying vessel which the Government of India have ordered from England, the requirements of the naturalist, especially for deep-sea dredging, &c., may not be forgotten.

Dr. Armstrong has, with very scant means and limited time, made a most interesting little collection, for the details of which I beg reference to extracts from his report (see Appendix G).

A. DUNDAS TAYLOR,

*Commander (late I. N.),
Superintendent of Marine Surveys.*

APPENDICES.

A

Extracts from a Report on the Ports of Burma, by COMMANDER A. D. TAYLOR
(late I. N.), F.R.G.S., *Superintendent of Marine Surveys.*

CHITTAGONG.

THE British India Steam Navigation Company's Steamer *Mahratta* called at Chittagong on 9th October; Captain Pollock, being well acquainted with all these ports, passed in between the outer channel buoys, but had to wait there for half an hour, whilst the pilot (native) made his slow way on board in a tub of a boat certainly never intended for pulling.

2. I found the Admiralty Chart No. 84 very defective; Mr. Pearson's latest survey of the river had not been used for its correction. If the Government of Bengal will supply me with a copy of Mr. Pearson's work, a trifling improvement can be made.

3. But the correctness of the soundings near the river Bar is the most important matter. There the chart seems deficient. The British India Steamer *Penang* had, a day or two previously, grounded on a shoal (not on the chart) near the South buoy after she had passed out between the buoys. This question should be looked into by a competent surveyor and the South buoy moved out further, if shoal water lies beyond it. The fact is that the Admiralty Chart is wrong, and has been wrong for years, and nobody apparently takes the trouble to mention the matter.

4. For the first time I have now been able to discover that the two lights at Norman Point are horizontally apart about 50 yards, and not, as stated in the Admiralty Light List, vertically 8 feet apart.

It is said that the two lights appear in line when a vessel is on the line of shoalest water upon the bar; but the bar shifts, and it is reasonable to ask the question,—is one of the lights shifted occasionally?

AKYAB.

The Admiralty Chart of this place, No. 1884, is imperfect and rendered treacherous to navigators, because the Bar buoy is now in a position differing from that given on the chart. This circumstance nearly led the *Mahratta* into trouble on a previous visit to this place in the bad weather of August. The rule was, and still exists in Sailing Directions, to steer for the highest land of Borongo, and when the Bar buoy is sighted, you steer to pass southward of it and then haul up north a little westerly. This course the *Mahratta* initiated; but, when near the buoy, got a cast of $2\frac{1}{4}$ fathoms (little more than her draught). She had to back out and steer to the southward for more than a mile, before hauling up north.

On my visit I took angles and bearings and found the buoy to be placed about a mile to N. N. W. of its assigned position on the Admiralty Chart No. 1884.

I have already reported (see letter No. 211, dated 30th August 1875) the necessity of a survey of the neighbourhood of Akyab. This would satisfactorily determine the position of the new Oyster Reef Light-house and set matters right in these parts.

Colonel Ryan, the Commissioner of Akyab, mentioned the difficulties they have there in the absence of any steamer to go off to ships and to place the buoys in position.

When the Oyster Reef Light-house is finished, it would be a great advantage to furnish Akyab with a wooden steam-launch (life-boat) about 50 or 60 feet long, a good sea-boat.

KYOUK PHYOO.

There is no trade to speak of here. The chart is good, and the dangers bordering the fair channel are marked by buoys. It is rumoured that some of these buoys are to be removed. I trust that this may be prevented. With the aid of these buoys a steamer can safely leave this port now on a moon-lit night.

THE TERRIBLE ROCKS.—The proposal to put a light on these rocks was lately submitted to Government by the Military (Marine) Department, and the question appears to be now several years old. The trade of Kyouk Phyoo does not call for a light there, and its necessity can only be taken into consideration in a general systematic scheme for light-houses throughout the Bay of Bengal, which I propose to submit soon for the consideration of the Government of India.

BASSEIN.

The Chart No. 834 of the approaches to this place is imperfect and likely to lead ships into danger. The shoal water around Diamond Island and the Phaeton Shoal has not been properly nor sufficiently sounded and delineated; neither has the anchoring ground lying to the east of the above island. The Northern channel—leading on round Negrais and Pagoda Point and through to the north of Hingie Island—is reported by the Master Attendant to have shoaled very much of late years, and a ship could *not* follow the existing directions and

run in there. But the chart still shews a deep passage; this is highly dangerous and might lead a vessel to her destruction.

2. The South Red Buoy of the Orestes Shoal (marked on the Admiralty Chart) was more than once or twice washed away. The replacing of it appears to have given trouble; and so now it is not placed there in reality, although shewn on the chart.

3. DANGER.—It is my duty to point out that great danger arises, not so much from removing a buoy, as from the fact that due notice was not formerly given of such removal to the Hydrographer. But it is hoped now that a Government circular may issue to all the Marine authorities, informing them of the necessity of constantly reporting to the Superintendent of Marine Surveys any change of position of buoy, beacon or light.

Again, to allow a deep channel to be shewn on the charts where (the fact being locally well known) there is shoal water, betrays negligence or indifference on the part of somebody which can only be partially palliated by laying the omission or neglect at the door of the incumbent's predecessor—a course adopted by the Master Attendant of Rangoon in the matter of the China Buckeer light, but a course that should not be allowed. When it is considered that these Port authorities are the officials that sit on Marine Courts of Enquiry into wrecks or disasters to shipping at their own ports or along the coast of the province to which they belong, it may easily be guessed (as pointed out in my remarks upon last year's "Wreck and casualty statements," dated 24th July, sent with this office memorandum No. 81 O. M., dated 26th July) how shipmasters are pretty sure to find all the blame falling upon themselves. I shall revert to this subject in another letter upon Rangoon approaches and the survey of the Burma Coast.

4. The Bassein River is deep, excellent, and easily navigable. The pilotage question here might be advantageously enquired into. Pilots have shares in a steam-tug, and therefore refuse to take large ships in or out without steam. They can ask what they like. The *Earl of Zeland*, a large ship, in October last, had to pay Rs. 2,200 for being towed up to Bassein, drawing 16 feet and coming out when drawing 20 feet 6 inches.

5. Going up the river, I found that on the Admiralty Chart the Cockatoo Rocks are shewn off the *East*, instead of the *West*, shore. I shall inform the Hydrographer of this and get the necessary alteration made: I merely mention it to shew how little thought has been bestowed upon the amelioration of our charts by men who are well paid for doing something.

RANGOON.

The temporary light-vessel, in *lieu* of China Buckeer light, is placed on the Admiralty Chart No. 823, about three miles too far west. This error evidently arose from a lack of perspicuity in the Notice to Mariners issued by the Superintendent of Burma Light-houses (to which I had occasion to draw the attention of the Government of India in letter No. 153, dated 30th June 1875). And I would here mention that the information sought by me in that letter has never come, and no reply was given to my remarks on that point.

2. The position assigned to the new screw-pile light-house, said to have 12 feet at low water, has $3\frac{1}{2}$ fathoms marked on the chart. If the piles are in 12 feet water really, and the structure has been moved 5 miles to S. E. by S. $\frac{1}{4}$ S., as stated, it is clear that the old position assigned to China Buckeer light was in error to the extent of more than one mile. My bearings from the outer Black Buoy, supposing that to be correctly placed as regards Eastern Grove light (see also paragraph 4), make the above error to be more nearly one mile and a half. This error—at least this supposed error—will soon be substantiated or refuted by the observations that are being made at Rangoon. It may account in measure for two of the British India steamers grounding, with China Buckeer light bearing N. by W. five or six miles off (see Wreck statement for 1874).

3. The sunken buoy-vessel *Mata Mata* is allowed to lie there about $1\frac{1}{4}$ miles S. S. W. of Fairway Buoy, standing upright on the bottom of the sea; her two masts afford a warning by day, but by night no precautions are taken to mark her position. I have already addressed the Government of India on the subject of the *Mata Mata* in letter No. 252, dated 18th November, to the Under Secretary.

4. The steamer took less time in passing from Fairway Buoy to upper Black Buoy than was consistent with the distance as shewn on the chart, taking the tide also into consideration. On arriving at the Black Buoy, I found that the bearing of the China Buckeer old light-house differed a *point* from the bearing on the chart. This difference shews that the China Buckeer old light-house (and consequently the newly-erected one on screw-piles) is considerably out in latitude. We shall soon now ascertain its real geographical position from the officers of the Great Trigonometrical Survey who have just fixed it.

5. Although Mr. Pearson's survey of Rangoon River in 1866 was lithographed, the Admiralty Chart No. 834 still retains merely Ward's more ancient survey of 1852. The Pilots complain that they are prohibited from using a good channel which was shewn by Pearson's survey between Elephant Obelisk and Eastern Grove, and which would materially expedite the passage of ships up the river in the south-west monsoon. They are told by the Master Attendant that it is not an authorised channel.*

6. Several excellent beacons are erected along the banks of this river, but they are not exhibited on the charts, because (as stated in my covering letter No. 285) the Marine authorities know not how to fix their positions and place them accurately on the chart.

* It has since been ascertained that no good channel exists in this locality.

7. The pilot schooner was anchored about two miles to south-east of the Fairway Buoy, but from this position the light of the temporary light-vessel was not visible to the eye without a binocular glass, although barely six miles off. On enquiry I was told that there was no specially responsible man of the Master Attendant's Department on board of that hired vessel (hired consequent on the sinking of *Mata Mata*, which was originally advertised as a temporary light-vessel) to see to the cleaning and trimming of the lamps. Two lights in fishing-boats which I observed lying to the east of the old China Buckeer light-house, which lights might easily have been mistaken by a stranger for the temporary light-vessel. Burning a blue light every hour is all that distinguishes that vessel, and it is devoutly to be hoped that the new light-house will soon be ready.

8. The bank on the eastern side of the entrance, as shewn on the Admiralty Chart, differs immensely from the reality. We went into the Rangoon River in the Steamer *Burma* on the last of the ebb tide (date the 22nd October) right over the bank and very close to the place marked "dry in patches," but had not less than $3\frac{1}{2}$ fathoms.

9. As several groundings and losses have occurred during the last two years in the vicinity of Rangoon, it would be interesting to learn what charts were lying open before the Marine Courts when they gave verdicts against the shipmasters whose vessels had grounded. Perhaps, the Government of India may now feel inclined to call for information on this point.

10. I was rejoiced to learn from Mr. Rivers Thompson, the Chief Commissioner, that the Assistants of the Great Trigonometrical Survey at Rangoon were about to determine the exact position of the China Buckeer light.

MOULMEIN.

This river ought to be better managed than any I have mentioned; because, besides a Master Attendant, Moulmein has a River Surveyor and a buoy vessel. Steam-tugs are always now used here, and this reduces to a minimum the chance of an accident. Of course the Admiralty Chart No. 1845 was wrong, for the reasons already given, *viz.*, it has been nobody's business to suggest or effect a periodical rectification of the charts.

2. The Master Attendant, Mr. Dodd, obligingly lent me the chart of Mr. Pearson's survey executed in 1865. It appears that this was given in by that surveyor to the Moulmein authorities, with the intimation that it was of no use lithographing the chart, because the channels were sure to alter. Thus, there are (I believe) no copies of this work to be found in Calcutta. Of course, such a chart is of little value to navigators, but to a Survey Department it has an important negative value, similar to Rennel's maps of the Ganges and Brahmaputra, as shewing, on comparison with a fresh survey, the secular changes.

3. Mr. Pearson's survey of this river, like those of Chittagong and Rangoon, was very incomplete, owing to the desultory and unsystematic manner then in vogue of doing these works. Several of a surveyor's station marks should be left, and then the gradual changes of the river bed can be at any time satisfactorily tested by a few angles. Not a single mark exists along the eastern shore for 20 miles above Amherst, but certainly two or three permanent marks should be left and made over to the charge of the shore authorities for preservation. The hills standing, about 200 feet high, a mile or two to south-east of Amherst are not represented on any charts, although their peaks form (in combination with the pagodas at Amherst Point) admirable leading marks for the river channel and landfall marks for the coast.

4. As stated above, there is a river surveyor here. If his periodical surveys are worth anything, we should have copies sent to our Department for incorporation in our charts. Although the entrance of Moulmein River requires to be properly surveyed and to have (as pointed out above) station marks left there, so that future surveyors may accurately test the changes, yet the means at my command will not permit a survey there during this season.

CONCLUSION AFTER INSPECTION.

Seeing that as yet no information has been sent direct, in accordance with the Government of India's letter of 11th August 1875, quoted in paragraph 9 of Government Resolution constituting the Department of Marine Surveys, by any Port authorities, Local Governments or Administrations to the Superintendent of Marine Surveys in the matter of lights, buoys, &c., it is suggested that the several Governments and Commissionerships, and the several native principalities bordering on the sea, should be moved to furnish immediately and periodically to the Superintendent of Marine Surveys the following reports:—

2. Announcing removal or change in position of, or any accident to, lights, light-vessels, buoys, beacons, &c.
3. Discovery of any shoal or rock, or of any error in any chart.
4. Disasters to shipping to be duly reported with the supposed causes thereof, and in case of stranding, a report shewing what charts and books of sailing directions were in use on board such ship.
5. Each Master Attendant or port officer to report whether he considers the system of lighting and buoying his port as good as might be.
6. Each Master Attendant or port officer to furnish the Marine Survey Department with a copy of the pilotage and port rules in force at their respective ports.
7. Statement of the establishment in men and boats employed by the Master Attendant of each port, shewing also the system of pilotage (whether Governmental or private), number of pilots and pilot-vessels, tonnage fees, and estimated tonnage of ships clearing outwards and inwards. Also noting whether any, and how many, tug-steamers, public or private, are employed.

B

Memorandum by COMMANDER A. D. TAYLOR on Surveys needed along the West Coast of India, forwarded to the Government of India with letter No. 172 of 1875, dated 16th April 1875.

REFERRING to Resolution of the Government of Bombay, dated 28th January 1875 (No. 110, Marine Department), in which the Superintendent of Marine Surveys is invited to state whether he considers it advisable to cause any, and what, surveys to be made along the seaboard of Western India, the following memorandum has been drawn up.

I.—Ports on the Western Coast, south of Bombay, including Goa.*

Batkul (formerly *Baticolo*), the most southern port of the Bombay Presidency, has only been partially examined, and is shewn only on the general sheet of the South Canara Coast on a scale of half an inch = one mile. It must, however, be many years before attention can be given to these minor ports.

Honore, *Coomta*, and *Tuddri* are shewn on the coast charts with tolerable accuracy. *Tuddri* is done well on a large scale.

Gungaweli, *Bellikerry*, *Binghi Bay*, and *Anjideva Roadstead*, as ports of little consequence, are sufficiently well delineated for the present trade.

Carwar is well known, but the shifting mouth of the Sedashigar river needs periodical examination; however, the port officer doubtless sees to this. The minor Goanese ports between *Carwar* and *Marmagoa* want more examination, but must wait many years.

Marmagoa River.—The entrance is a complete blank, and it would be well to ask the Portuguese Government to give their assent to the execution, by our trained surveyors, of a careful survey of the *Marmagoa* river entrance, which is one of the west coast ports of refuge.

Goa port has not been thoroughly examined, and the only published chart of that place is on the small scale of half an inch = one mile. Perhaps, the Portuguese Government might be persuaded to survey their own ports, including *Diu* and *Damaun*. It will be some years before we can undertake any further operations on the *Goa* coast; and the general charts are sufficient for coasters.

Vingorla is so important a commercial port, that the anchorage needs to be most carefully surveyed on a large scale. This is one of the first ports on the west coast which call for examination, but I cannot hold out any hopes of its being done for the next two years.

Malwan requires to be minutely surveyed on a large scale; and the clearing marks for the *Malwan* rock and other dangers need to be ascertained and indicated.

The seven ports as per margin have only been partially surveyed. For the greater	
<i>Dewghur.</i>	<i>Kalbadeli.</i>
<i>Viziadroog.</i>	<i>Jaighur.</i>
<i>Rajapoor.</i>	<i>Hernee.</i>
<i>Ratnaghiri.</i>	

security of the large steamers now calling there, they require to be thoroughly done on a large scale. This must, however, be a work of time.

Jinjera port, belonging to the *Habshi*, has never been thoroughly surveyed, but requires to be.

Chawal and *Alibagh* should also be more accurately done.

Bombay Harbour.—There are various internal portions of this harbour that need to be surveyed to supplement the survey by Lieutenant *Whish*; but his chart is sufficient for the present. It would be a great service if some one with a knowledge of surveying could (in conjunction with the Pilots and Master Attendant) draw up a new set of marks for working out of and into the harbour, making use of the lofty new buildings which quite eclipse the old marks.

II.—Ports on the western coast north of Bombay, including the Gulf of Cambay and the ports on the Kattywar coast.

Gulf of Cambay.—It will be seen (at page 20 of my "Review of charts and scheme for future surveys") that I consider this as the fifth survey in importance, and to come after that of *Sittang* river mouth. We now have all the Grand Trigonometrical Survey of *Kattywar* and *Goozerat* as the groundwork of our new labours. I reckon this survey to commence a few miles southward of the *Tapti* river mouth, and to extend to a dozen miles westward of *Goapnath* point, taking in the *Malacca* banks. Having the Great Trigonometrical Survey triangulation, we can commence anywhere to survey a portion; and if circumstances (such as a more pressing demand for the services of the surveyors elsewhere) should necessitate breaking off work there, it could be easily taken up again.

With the view of meeting the wishes of the Superintendent of the Bombay Marine, I made a suggestion in paragraphs 4 and 5 of my letter No. 8, dated Bombay, 3rd February 1875, about employing two Royal Navy Officers in surveying the neighbourhood of *Kantiajal* creek with certain means which had been previously arranged by Captain *Robinson* at an estimated cost. On 23rd February I telegraphed from *Calcutta* that two trained surveyors could then be sent. Their employment at that time would have been an advantage, but for a more extended survey of the *Gulf of Cambay*, which should include the *Kantiajal* creek, I think we shall probably have to wait three years.

* I do not include in this memorandum any of the *Madras* ports or *Travancore*.

The foul ground off *Danob* is the principal portion requiring examination between Bombay and Surat; it is a rocky and dangerous place, but properly avoided on that account. I think therefore that nothing will be lost by postponing its examination till the Surveyor General's operations have extended to that coast.

Agansee and other minor ports may soon demand a more accurate survey.

Damaun, belonging to the Portuguese, is a port that deserves to have a chart on a good-sized scale.

Omersari.
Bulsar.
Nowasari.

These three ports as per margin and the mouth of the Sucheen river will call for examination at some distant date.

The mouths of the *Tapti*,

Koonbunder.
Baoliari.
Soondri.
Bhaonaga.

Narbada, *Mkhe* and *Sabarmati* are so changeable, that unless annually examined and corrected, their charts would only mislead; and such annual examination would be too costly. They will come in with the Gulf of Cambay survey, which will also include the ports as per margin.

Gogo roadstead has never been thoroughly surveyed, and should some day be well done by means of a steam-launch.

The same remark applies to the ports as per margin. I have found Captain Grieve's original large scale triangulation survey of the Kattywar coast amongst the 3,000 old charts condemned to be burnt.

Shalbet anchorage.
Jaffrabad.
Diu.

Varawal.
Porbunder.
Dwarka.

I hope in the course of this year to produce better charts of Kattywar for the use of navigators.

The Gulf of *Kutch* has ports that may soon require more detailed surveys when coasting steamers call there. The most important are *Seraia* and *Nowa Naga*. *Beyt* may hereafter require a closer examination than was made by me in 1852; but the Admiralty Chart of that place does well for the present.

Mandavee.—We have found an original large scale plan of this place which may be published on the coast sheets; but, some years hence, *Mandavee* should be re-surveyed.

The mouths of the *Indus*.—Periodical examination of the increasing and shifting banks off the principal mouths of the *Indus* will have to be made about every ten years; but as this year's survey will not do for the next year, it will be best to warn vessels off that coast.

C

Remarks by NAVIGATING-LIEUTENANT G. C. HAMMOND, R.N., Assistant Superintendent, 1st Grade, Marine Survey of India, on the LIGHTING of the PORT of COCANADA, dated 19th September 1875.

IN reference to the wishes contained in your letter No. 156 of 1st July 1875, respecting the lighting of the port of Cocanada, I beg to submit the following for your consideration.

I will answer your questions *seriatim* as contained in your letter:

- A. Q.—Whether new light or lights are necessary?
A.—Two new lights are required.
- B. Q.—If so, whether light-house, pile-light, light-vessel or both?
A.—Both light-houses.
- C. Q.—What order, description and elevation?
A.—Point Gordeware light should be of the 1st order dioptric shewing a distance of 21 miles at an elevation of about 170 feet, and Cocanada Harbour light should be of the 3rd order dioptric shewing a distance of 10 miles at an elevation of about 70 feet.
- D. Q.—The exact position to place either or both?
A.—Point Gordeware light should be placed just inside high-water mark on the projecting part of the point bearing from the present Hope Island light S. 20 E. and at a distance of 4.7 miles.
Cocanada Harbour light should be at 4.68 miles N. 22 E. from the present light-house.

My reason for naming a spot so far to the southward for the Gordeware Point light is, that it might be made use of as a "landfall" light for ships working up or down the Bay of Bengal, and that it might be utilised also to point out the Sacramento Shoal, which would then lie about 16 miles in a S. S. W. direction (the bearing and distance approximate, as it has not yet been surveyed), a red shade being inserted on the danger bearing; by using a similar shade, throwing the light between the bearings N. by W. to N. N. E. would assist a vessel in keeping clear of the N. E. part of the Spit, as the latter bearing cuts the present ten-fathom contour abreast the Outer buoy.

Not having any boring tools, I am not in a position to give the nature of the ground for a foundation, but I found sand to a depth of about 6 or 7 feet, and I think the stone, &c., necessary both for a foundation and the light-house itself might easily be obtained a short distance up the River Godavery, a branch of which runs close at the back.

At this point also the water appears to run out shoal for a considerable distance, no doubt in bad weather causing a considerable sea: from information I gathered from the light-house-keeper at Hope Island, ships have, several times, reported a separate shoal some two or three

miles off this position of the coast, but from observations I made on the beach, and again from the summit of Hope Island light, I could see nothing detached, and I think the reports must have arisen from the vessels having been too close in shore to the southward and having seen the broken water off this point:—therefore a light in this position would greatly assist a vessel in keeping clear of any danger lying off.

My reasons for thinking a shore light will be the best for Cocanada are—

- 1st.—If it is constructed with an iron pile frame-work, it can easily be moved as the bay fills up, and, being on shore, it will not have the extra risks which a light-vessel would have to encounter, such as vessels fouling her, or being driven from her moorings.
- 2nd.—It will eventually cost less than a good light-vessel.
- 3rd.—I think at the position marked on my plan an excellent foundation will be found, besides allowing plenty of room for the keepers, dwellings, store-houses, &c.

This light also might be fitted with a coloured shade to enable a vessel to keep clear of the north part of Gordeware Point, *viz.*, from S. 51 E. round to the southward, the point having grown out in a N. E. direction during the last 29 years about two miles, one mile and a half of which has accumulated since your survey in 1857. I think it would be advisable that the coloured shade should be made to shift if necessary, in order that, as the point grows out to the northward, the bearing of the coloured light might be altered also.

With such a light as mentioned above, I venture to think the convenience of the port would be better served than by having a pile-light, as suggested by Colonel Fraser, R. E., (I have marked in my plan the position suggested for the pile-light, as shewn to me by the light-house-keeper at Hope Island), or a light-vessel, as suggested by Mr. Robertson, Harbour Engineer.

My objection to a pile-light-house in such a position is, the tremendous action of the breakers, with an on-shore gale, against such a structure, taking into consideration the undertow and the foundation, which, I think, would not be found very good; and, again, it would have to be shifted to the N. E. as the land grew out in that direction, or otherwise it would eventually be somewhere inland, like the present Hope Island light, and consequently would become as useless.

With respect to a light-vessel, I see only one thing in its favour, and that is it would be cheaper in the long run; against such a light there are several grave objections, *viz.* :

If it should be moored to mark the north end of Point Gordeware in 5 fathoms (somewhere near the present inner harbour buoy), it would have to contend with a very nasty, short choppy sea, caused by the freshes (at this time of the year) coming out of the Godavery, meeting the wind and sea brought up the coast by the S. W. monsoon; and again, vessels, standing in or out, have to keep their luff and shave the point as close as possible to avoid being set to leeward, thereby entailing a chance of fouling.

I think a light-vessel, moored in such a position, would be safe, as far as holding is concerned, even in a cyclone; the only danger being her parting, occasioned by a sudden jerk on the cable, owing to the heavy sea which would then be running. I am told the worst quarters from which it blows are N. E. and S. W. If she parted, with the wind at N. E., she would drift in, about W. S. W., through very soft mud, which would also act as a sort of break-water; and if it came from the southerly quadrant, she would be blown out to sea.

Again, if the light-vessel was moored somewhere in the middle of the roadstead, I am afraid it would occasionally be taken for a ship at anchor, thereby rendering it nearly useless as a light-vessel, and it would still run the chance of being fouled.

I am afraid I can give you very little useful information respecting Cocanada Bay as a holding ground in a cyclone. I only heard of one casualty from such a cause, and that occurred some 15 years since to a native craft, and the accepted idea is, she was lost through defective ground tackle; it is said there is very little sea except off the Spit, considering what one would expect on a lee-shore in a cyclone, and the best thing a ship can do is to give a good scope of cable and drop a second anchor under foot, and then let her drag through the soft river mud, which comprises the bottom of the Bay; by so doing, a properly equipped vessel, with a decent crew, ought not to come to any great harm, except in the case of small vessels, which generally get everything swept off their decks. Hoping that my remarks on the lighting of the port of Cocanada will meet with your approval, &c.

D

*Report upon certain proposals for a reorganisation of the River Hooghly survey drawn up by
COMMANDER A. D. TAYLOR, late I. N., Superintendent of Marine Surveys, (dated the 19th
February 1875).*

1. AN elaborate and scientific survey of the whole tidal basin of the Hooghly river, or at least from Chandernagore to the Sandheads, is most certainly required, and should be executed as soon as possible. Indeed it is a great pity that the recommendations of the Committee of 1854 were not acted upon, *viz.*, that “*minute and periodical surveys of the whole length and breadth of the river from Calcutta to the sea are necessary,*” because the charts of the present survey were found “*altogether insufficient for engineering purposes.*”

2. More than 20 years have passed away, and we have still to deplore the omission of any such scientific survey. We are left to guess what changes may have taken place and the causes of those changes. Shall we bequeath to another generation this important work and our regret that it had not been begun many years previously?

3. The unscientific method of the existing river survey, the counterpart of that which was executed by Captain R. Lloyd, of the Indian Navy, nearly 40 years ago, with its imperfect *matériel* and rough *personnel*, and consequently unreasonable cost, is denounced by any hydraulic engineer who comes in contact with such primitive work. "The resulting charts are altogether insufficient for engineering purposes, and will be of little or no assistance hereafter in determining the causes of change or deterioration in the river."

4. I have no desire to depreciate the labours of the river surveyor, which are confined to ascertaining and recording the navigable channels. I believe his work to be executed on the basis and principles adopted by the old Indian Navy surveyors when taking the off-shore soundings along a coast and in the harbours of Asia. But those surveys were merely preliminary. We now know that for accurately delineating river channels, nothing but sectional sounding in steam-launches will suffice. Drifting about in a row-boat at the caprice of the tidal stream, and dependent upon the varying speed attainable by a dozen weak rowers or a fitful wind, the cleverest marine surveyor could not produce work that would stand the criticism of a practical harbour engineer.

5. With such convictions it becomes my duty to declare that I cannot endorse the opinion of the Officiating Master Attendant in paragraph 5 of his letter No. 4219, dated 2nd July 1875, to the Government of Bengal. The state of the channels, sands, and bed of the river cannot be ascertained by "trigonometrical measurements" made annually and from time to time. Measurements to ascertain the configuration of the foreshore, leaving *pucka* bench-marks by levelling all the way from above Calcutta to at least Diamond Harbour, should be accurately made once for all, embracing as shore marks all light-houses, flagstaves, beacons, obelisks, temples, houses, and remarkable objects; whilst other permanent station points, boundary pillars, and tidegauge stations should be left near the river margin and on some of the large sand-banks which are uncovered at high water of neap tides.

6. The assertion that the present surveys are "*all that can be desired for information so far as the bed of the river, its channels, and sands are concerned, either for engineering or navigating purposes*," cannot be accepted as correct in the face of the following fact. *The inclination of the bed of the Hooghly river has never* yet been determined, and can only be determined by an accurate series of levels taken from above Calcutta to below Diamond Harbour (say, to Rungafulla).* Proper measures for determining this *slope of the riverbed* must be adopted before any design for improvement can be formed, and (I would add) before the soundings taken can be properly reduced to any correct datum levels.

7. Tidal observation stations are now few and far between. The soundings taken (for instance, between Diamond Harbour on the one shore and Diamond Point on the other), whether reduced by the Hooghly Point's tidegauge or by that of Middle point below Rungafulla obelisk (which gauges are 20 miles apart), will differ several feet. *Intermediate stations* for tidal observations must be multiplied to ensure anything like accuracy in our plans of the river. At stations several miles apart, the times of high and low water will surely be found to vary much, the difference being due at times more to the state of the wind than to the fact of the tides being neap or spring.

8. I would ask the Government of India to inspect the chart of the survey of the James and Mary shoals executed between mid-April and mid-May of last year by the officers of the *Guide*, and to compare it with any of the river surveyor's charts of the same spot. Soundings can only be correctly taken *sectionally* in a river, after erecting section poles. With such poles, placed as fixtures abreast of channels where frequent changes take place in the bed of the river, these sectional soundings may be repeated day after day or week after week, and changes in the channels immediately made known to the pilots. This is what the pilots want. And for this purpose I highly approve of Mr. Chitty's proposal to have a central office for completing the plotting and drafting of charts by the surveyors at Diamond Harbour.

9. The proposals of Mr. Chitty and the Port Commissioners both indicate the importance and necessity of having distinct surveying services for the portions of the river *above* and *below* Diamond Harbour. The one is purely river work, the other is distinctly sea work. Not having had the opportunity I expected of going down river in the *Celerity* to make more enquiries on the spot, I see nothing at present to modify the view of the question which I have entertained for some weeks past, *i. e.*, that a combination of the schemes proposed by Mr. Chitty and the Port Commissioners commends itself.

10. The Officiating Master Attendant says (paragraph 13) "steam-launches are of little or no use below Diamond Harbour, except in the very finest weather." But Mr. Chitty defines the kind of steam-launch he would employ in paragraph 4 (*f*) of his letter, dated 26th January 1871, as "*capable of going to Saugor anchorage in the south-west monsoon*," and having "*comfortable arrangements for surveying officers forward*." Two steam-launches of that description would, in my opinion, amply suffice—along with the steam-buoy vessel and surveying vessel combined of about 800 tons (see paragraph 11 of Port Commissioners' scheme dated 17th April 1875)—to do all the sea section surveying work, *without* the first steam river surveying vessel, as stated to be required by the Officiating Master Attendant and river surveyor in the letter of Bengal Government (Marine), No. 449, dated 12th February 1875.

* A series of levels has since been taken and bench-marks left by the Irrigation or Revenues Survey Department.

11. It is presumed that the *Celerity* will still be available to assist in the work pointed out by the Officiating Master Attendant in paragraphs 16, 17 and 18 of his letter No. 4219, dated the 2nd July 1875. If the *Celerity* be available, I venture to think that the large steamer of 250 tons would not be required, and I state this with a full knowledge of what is said in paragraph 18 (just alluded to), that "*there can be no hope of this additional duty being accomplished with a flotilla as suggested in the Port Commissioners' scheme.*"

12. Amongst the correspondence concerning the River Hooghly survey, I find that the Government of Bengal has represented to the Government of India (see letter No. 581 (Marine), from the Secretary of Bengal Government, dated 22nd February 1875) the absolute necessity of having a *second* steam-buoy vessel and surveying vessel combined, for the purpose of the buoyage of outports under the Government of Bengal. I am therefore decidedly of opinion now that two such steam-buoy vessels will best subserve the interests of both the surveying and buoying work for the Hooghly and outports; and that the proposed steamer of 250 tons would then be a superfluity.

13. I think it would be well that a committee of practical land and marine surveyors should go into this subject before a final decision be made as to reorganisation. But the important preliminary work which I have indicated in paragraphs 5 to 7 should certainly be commenced and carried out at once by land surveyors. Much advantage will result from having it done before the vessels are ready to undertake the sounding.

14. In conclusion I would observe that the printed statement of the Port Commissioners, shewing the "present and proposed scale of establishment," seems carefully and correctly drawn up, and their proposed vessels would be competent to perform the two sections of survey work which I have indicated in paragraph 9 above.

E

Remarks by NAVIGATING-LIEUTENANT F. W. JARRAD, R.N., Deputy Superintendent of Marine Surveys, 2nd Grade, on the lights and buoys in the approaches to Rangoon River, dated 29th May 1876.

WITH reference to the light at Eastern Grove—this light is visible between North and N. E. by E. $\frac{1}{2}$ E.; it, however, is supposed to shew more brilliantly, over an arc of 10° , between the bearings of N. N. E. and N. N. E. $\frac{1}{2}$ E. nearly, for the purpose of indicating the fairway channel; but the increase in brilliancy is so very gradual as to render it impossible to define the limits of the arc of greatest brilliancy with any certainty. I would therefore suggest that the light should be coloured red over the Eastern and Long Sands, that is, between N. and N. by E. $\frac{1}{2}$ E., and also over the Spitsand, that is, between N. N. E. $\frac{1}{2}$ E. and N. E. by E. $\frac{1}{2}$ E., leaving a bright white light between, over an arc of 10° , to indicate the fair channel. A vessel then approaching the banks on either side would immediately, on seeing the light change colour, become aware of her danger. At present, as I have already stated, the change from a bright light to a brighter ray is not sufficiently apparent to be of any practical utility for giving warning of a vessel's proximity to danger.

If the above proposal were carried out, the Eastern Grove light could then be utilised as a leading light for vessels leaving the river; otherwise, it is of very little value, as, now that China Buckeer light has been placed in its new position, the China Buckeer light becomes the landfall light for Rangoon river.

2. With reference to the light on China Buckeer flats:

The western limit at which the China Buckeer light is at present cut off allows the light to shew over the banks off the mouth of the *To Kwa* (China Buckeer) river. This may lead a vessel into danger more particularly until the exact limits of the light are universally known. I would recommend that the limit be altered to N. E. instead of N. E. by E. $\frac{1}{2}$ E. Had a careful survey of the locality been made before the position of the China Buckeer light was decided on, it would have been apparent that it should have been placed one mile further to the south-west than it now is. A vessel then making the light and steering for it could not, as long as she kept it in sight, get into danger.

With the present arc of visibility, should a vessel approach the light on a bearing east of N. N. E. $\frac{1}{2}$ E., she would be in great danger of taking the ground on the sand banks to the south-west of the light. I would also draw attention to the fact that, apparently, the Marine Survey Department was not referred to for an opinion on the subject before the new position of the light was fixed upon or the arc of visibility determined.

3. With regard to the buoying, I have noticed that no uniform system of buoyage appears to be carried out in India, and I beg leave to draw your attention to the great disadvantage of placing buoys in a channel the colour and construction of which do not at a glance convey an idea of the general nature and position of the dangers which they mark. I would therefore suggest that a uniform system of buoyage should be introduced, assimilating, as nearly as possible, with that used by the Corporation of the Trinity House, London, and that this system should be compulsory in all ports and rivers of British India.

4. With the above object in view, I respectfully suggest the following alterations being made in the character, &c., of the buoys at the entrance to Rangoon river:

(a) That the present Fairway buoy be called the "Outer buoy" (as it undoubtedly is), and that the name "Outer" be painted on it.

- (b) That the present Outer buoy be called "Fairway," it being placed in the Fairway channel, and the name be painted on it as above: both the buoys, as well as the Spit buoy, should be conical in shape and larger than those now in use.
 - (c) Referring to the accompanying tracing, it will be seen that the position marked A, close to the edge of the Long Sand, requires to be buoyed. It is one of the most dangerous spots in the channel; several vessels have been lost there, and the hull of one is still to be seen at low water. I would therefore propose that an additional buoy be placed in the channel to mark this spot.
 - (d) The present position of the northern black buoy is not a good one, as it leaves the edge of the shoal water in the narrowest part of the channel unmarked. I would suggest the desirability of shifting this buoy to the position marked B.
 - (e) I also propose that the northern red buoy be shifted to the position marked C; at present it is too close to the Spit buoy to be of any use.
5. Before making the above alterations in the buoys, I would urge the necessity for at once deciding on a system of buoyage as before mentioned.

F

Extract from a letter of proceedings from NAVIGATING-LIEUTENANT F. W. JARRAD, R.N., F.R.G.S., *Deputy Superintendent, Commanding I. G. Surveying Steamer Clyde, describing the coast between Akyab and Cheduba Island (dated Calcutta, 10th May 1876).*

1. ON the 1st of April the surveying work received a sudden check caused by the appearance of cholera on board the ship, resulting in the lamentable death of Sub-Lieutenant C. George, the particulars connected with which were reported in my letter No. 89, dated 4th April.
2. Several of the officers and men were attacked with similar symptoms, and to prevent, as far as possible, the epidemic spreading, a camp was formed on shore for the greater part of the crew. The ship was fumigated and cleaned throughout. As soon as Dr. Armstrong pronounced it safe, the men returned on board, and after filling up with coal, &c., I left on the 10th April, in accordance with the instructions conveyed in your letter, dated 5th April, for a course to the southward.
3. From the 10th to the 14th the ship was sounding and dredging between Akyab and Cheduba Island. I also took the opportunity of testing the accuracy of the chart between Kyouk Phyou and Cheduba, and found that the coast as shown on Admiralty Sheet No. 821 is out of bearing. There was also evidence of a considerable change having taken place in the depths in the channel between Cheduba and the Ramree Island since the last survey. The weather was not fine enough, neither did time admit of my making any close examination for the purpose of correcting the above very visible inaccuracies. The whole of this coast requires to be re-surveyed in a rigorous manner, and for this purpose a more suitable and better equipped vessel, and also a more efficient staff than that on board the *Clyde* at the time, would be necessary.
4. On the 13th the ship was dredging the whole of the day close to the Terrible Rocks. The heavy westerly swell which we experienced on this coast during the whole of the month prevented my landing on either of the groups. I am, however, of opinion that should the necessity for a light on these dangers arise at any future time, the north Terrible would be the best site, as it is more easily accessible, and a vessel could anchor nearer to it than she could to the south group. It would appear, however, that at present the necessity for a light in the Terribles does not exist, as there is hardly any traffic in their vicinity.
5. The weather was so threatening on the night of the 13th, that I deemed it advisable to seek shelter, and I therefore steamed into Southampton road, Kyouk Phyou.
6. On the 14th the weather still looked wild, and there was a very heavy swell from the westward, preventing any possibility of my landing on the Terribles; and as I had found the main points on Admiralty Chart No. 821 so relatively out of position as to preclude any possibility of my plotting deep soundings on it in a satisfactory manner, I so far departed from your instructions as to relinquish the sounding and determined on examining the harbour of Kyouk Phyou.
7. Between the 15th and 24th this examination was proceeded with, the main triangulation of the harbour was obtained, the buoys fixed, and the Bombay and Reliance shoals examined. I am plotting this on a dry proof of the published plan, and when it is completed, shall be able to inform you whether the coast and main points on the present plan are delineated with sufficient accuracy so as to necessitate only the re-sounding the port, or whether the whole plan requires re-constructing. Should the latter prove necessary, I can at once prepare the sheet. Information regarding the position of the buoys, &c., I have already furnished to your office.
8. Dr. Armstrong will furnish a *resumé* of the dredging operations. I believe new species of crustaceans and also shells have been found.
9. On the 24th I called at Akyab for letters and left, in accordance with your instructions, at day-light on the 25th for Calcutta, arriving here on the 28th; *vide* my letter No. 93, dated 28th April.

Extract from the report of SURGEON J. ARMSTRONG, B.A., Indian Medical Department, Surgeon and Naturalist to the Marine Survey of India.

1. The present Report is intended to be merely an outline sketch of the operations undertaken during the season in connection with my duties as Naturalist attached to the Marine Survey. I propose to give only a general idea of the nature of the ground over which the work of the season extended, and I will not attempt, therefore, in this place to give any technical classification or description of the fauna of any portion of the different districts which were visited. A detailed account of the genera and species met with is in course of preparation for publication in the Asiatic Society's Journal and will shortly appear therein.

2. All the shells which were collected during the season have been handed over to Mr. Nevill, of the Indian Museum, while the entire collection of crustaceans, which form one of the most numerous and interesting groups of animals belonging to the marine fauna, has been placed at the disposal of Mr. Wood-Mason for identification and description, that gentleman having long made this branch of the invertebrates his special study. I have reserved to myself all the ornithological specimens, as well as all the hydroid zoophytes which have been collected, and trust soon to complete a description of the most remarkable of these interesting groups.

3. During the months of December, January, and February our work was necessarily confined to the vicinities of the Rangoon River, between the Grove light-house on the east and China Buckeer on the west, embracing altogether a coast line of about thirty miles in extent. The marine zoology of this region is extremely scanty; the great rapidity of the tides, the brackishness of the water, and the enormous amount of mud and fine sand which is held in suspension by the water, and is constantly being deposited by subsidence on the bottom, are the factors which most powerfully co-operate to prevent the development and retard the growth of the marine fauna in this district. The littoral fauna, on the contrary, is abundant. Numerous species of crabs and other crustaceans are to be found along the beach and in the tidal swamps which border a portion of the shore, while the broad and extensive mud flats, which at low water are left uncovered, afford choice feeding ground for multitudes of shore birds of different species, such as *Squaterola Helvetica*, *Charadrius longipes*, *Agialitis Geoffroyi*, *Agialitis mongolicus*, *Agialitis cantianus*, *Agialitis Philippensis*, *Lobivanellus goensis*, *Edicnemus crepitans*, *Terekia cinerea*, *Numenius arquatus*, *Numenius phaeopus*, *Tringa subarquata*, *Tringa minuta*, *Tringa platyrhyncha*, *Eurynorhynchus pygmaeus*, *Actitis hypoleucos*, *Totanus glottis*, *Totanus calidris*, and others, including a hitherto undescribed species of *Totanus*. Of each of these specimens have been secured and preserved.

4. Commencing at about two miles to the westward of Elephant Point and reaching up to China Buckeer river, the coast is fringed by mangrove and tidal jungle, amongst which *Sonneratia apetala*, *Ceriops Roxburghiana*, *Clerodendron inerme*, *Hibiscus tiliaceus*, *Acanthus ilicifolius*, *Derris scandens*, *Flagellaria indica*, *Grewia microcos*, *Glycosmis pentaphylla*, *Basella alba*, *Jasminum scandens*, &c., are most conspicuous. A little inside this tidal jungle, and separated generally by open waste ground, are broad belts of savannah forest running more or less parallel with the shore, and in many places quite impenetrable by reason of thick thorny underwood. These belts of forest trees and thorny underwood give shelter to numerous birds, amongst which various species of parrots, wood-peckers, and drongoes, as well as pigeons and doves, are the most characteristic, while the mangrove jungle bordering the shore swarms with different varieties of herons and glitters with the gorgeous plumage of kingfishers and bee-eaters.

5. In March we left Rangoon and proceeded to Akyab, sounding and dredging several times on the way, and with results which, on the whole, were very satisfactory. Off Cape Negrais on each occasion upon which the dredge was used it was brought up filled with a slate-coloured tenacious mud, amongst which a single rare crustacean (*Raninoides laevis*) was found, as well as large quantities of dead pteropods of different kinds. In the more immediate vicinity of Akyab the ground was much more prolific and abounded in numerous species of echinoderms and crustaceans; several rare and beautiful hydroids and other zoophytes were also obtained.

6. Long before the contemplated work at Akyab was completed, an outbreak of cholera on board, resulting in the death of one of the officers, made it necessary to leave that port where the disease was at the time epidemic, and it was then intended to devote some little time to dredging in the vicinity of Cheduba and in the neighbourhood of the Terrible Rocks. Unfortunately, however, in consequence of unfavourable symptoms appearing in the weather, it was found impossible to carry out the dredging operations to the extent which had been originally intended, but nevertheless enough was done to shew that this entire region is extremely rich in many interesting forms of animal life, and would well repay a more careful examination at some future time. While dredging in the vicinity of the Terrible Rocks it was found that there is in this region a remarkable formation of bottom, in which, though unaccompanied by any change in the depth of the water, there is an abrupt transition from rock and gravel to a slimy, oozy mud, indicating probably the existence of some localised submarine current.

7. I deem it my duty to bring prominently to notice that, having regard to the working capacity of the natural history section of the Marine Survey, it is quite impossible to carry into execution the scheme of deep sea dredging which was originally proposed by the Council of

the Asiatic Society and which has received the cordial sanction of Government. Without machinery of any kind or any steam-power available for hauling in sounding or dredging gear, it is quite useless to attempt to dredge at any depth exceeding ninety or at the outside a hundred fathoms; and thus valuable opportunities are lost of making any systematic or serial observations upon the various currents and temperatures of the Indian seas, or of investigating the physical character of the sea bottom.

8. All available time has therefore of necessity been devoted to the investigation of the zoology of the shallower water; but even in this limited field, owing to the short time at our disposal for the work, and the consequent desultory and disconnected nature of the observations made, a maximum of useful work has not been effected.

9. I would accordingly venture to suggest that opportunities may be afforded for a more systematic and definite zoological investigation of the shallower water than was practicable this season, and with this object in view, I would recommend that a certain definite period, of not less than seven days in each instance, should be devoted to a careful zoological examination of each district where the surveying operations are at the time being carried on, the length and choice of time being left entirely to the discretion and convenience of the commanding officer. In this way the zoological faunas of definite areas would be tolerably correctly ascertained, and much more valuable results might be expected from such methodical working than from isolated and disconnected dredging carried on at more or less remote distances from each other.

I

Synopsis of the result of the observations made for determining the Meridian distance between ELEPHANT POINT (OBELISK), RANGOON RIVER, and AMHERST POINT PAGODA (FLAGSTAFF), between the 22nd February and 2nd March 1876.

[illegible]

Meridian distance from Elephant Point Obelisk to Amherst Point Pagoda.

[illegible]

Meridian distance from Amherst Point Pagoda to Elephant Point Obelisk.

[illegible]

Meridian distance from Elephant Point to Amherst.

STANDARD	H.	M.	S.
A	0	4	55.086
B	0	4	54.569
C	0	4	55.502
D	0	4	55.818
E	0	4	55.062
F	0	4	55.072
G	0	4	54.812
Mean Meridian distance	0	4	55.250
			586.944

Meridian distance from Amherst to Elephant Point.

STANDARD	H.	M.	S.
A	0	4	55-038
B	...	...	54-563
C	...	0	55-562
D	...	0	56-566
E	...	0	55-093
F	...	0	54-512
	...	...	536-904
Mean Meridian distance	0	4	55-273

RANGOON RIVER, }
The 4th March 1876.

F. W. JARRAD, *Navy. Lieut., R.N.,*
Commdg. I. G. S. S. "Clyde."

Comm'dg. I. G. S. S. "Clyde."

I

*Statement shewing the cost of the Marine Survey Department from the 1st April
1875 to the 31st March 1876.*

PARTICULARS.	Amount of each item.	Total of each heading.
	Ra. A. P.	Ra. A. P.
Superintendent of Marine Surveys	21,600 0 0	
Superintendent, Drawing Branch	7,959 10 11	
Office of Superintendent of Marine Surveys	4,325 18 2	
		33,885 8 1
<i>Contingent Charges.</i>		
Travelling expenses on inspection journeys	1,298 0 0	
Contingencies	3,089 10 6	
		4,387 10 6
<i>Scientific Officers.</i>		
Scientific Officers	44,965 9 3	
Allowance to one Surveyor as Draughtsman	600 0 0	
Medical Officer and Naturalist	4,800 0 0	
House-rent to Officers	6,298 7 2	
		56,664 0 5
<i>Executive Officers.</i>		
Executive Officers	7,295 7 10	
		7,295 7 10
<i>I. G. S. "Clyde."</i>		
Wages of Crew	18,440 7 9	
Contingencies	1,827 15 0	
Provisions	1,995 11 0	
Stores	3,461 2 9	
Repairs	2,136 0 0	
Coal	2,718 12 0	
Travelling expenses of portion of <i>Clyde's</i> Crew to Bombay	976 4 0	
		31,051 4 6
<i>I. G. Schooner "Constance."</i>		
Wages of Crew*	13,212 11 3	
Contingencies	1,016 8 0	
Provisions	1,924 7 10	
Stores	3,140 0 0	
Repairs	496 0 0	
Coal for Steam-cutter attached to <i>Constance</i>	167 0 0	
		19,956 11 1
<i>I. G. Brig "Guide."</i>		
Wages of Crew	7,458 9 4	
Contingencies	433 2 0	
Provisions	608 0 0	
Stores	1,695 0 0	
Repairs	1,257 0 0	
		11,451 11 4
<i>I. G. S. "Lady Lawrence."</i>		
Wages of Crew	968 6 8	
Contingencies	16 0 0	
Repairs	98 0 0	
		1,082 6 8
<i>Steam-cutters.</i>		
Coal	20 0 0	
Repairs	982 0 0	
		1,002 0 0
GRAND TOTAL ... ..	.....	1,66,771 12 5

* Pay of Executive Officer is not included in this.

A. D. TAYLOR,
Superintendent, Marine Surveys.

Programme of work to be undertaken by the Marine Survey Department during the ensuing season of 1876-77 (Extract from letter No. 476, dated 28th June 1876).

THE *Clyde* to leave Calcutta on 1st November for Amherst (Moulmein river), calling *en route* at Diamond Island (Bassein river), for the purpose of obtaining observations to enable a meridian distance to be measured between the above island and Amherst Point Pagoda. This will connect astronomically Diamond Island, Rangoon (Elephant Point Obelisk), and Amherst Pagoda—the three principal positions in the Gulf of Martaban about which there is uncertainty, whereas correct meridian distances are essential to the reproduction of a new chart of that locality.

2. On arriving at Amherst, I propose that a survey of the approaches and entrance to the Moulmein river be executed on a scale of 2·5 inches to the nautic mile. The present chart of Amherst and the Moulmein river entrance is from a sketch executed by Lieutenant Fell, I. N., so far back as 1842. It is so incorrect as to be quite inadequate for the present requirements of, if not dangerous to, navigation; and after personal inspection of the place in April last, I came to the conclusion that no large port in India so much requires a new and correct chart. This duty will probably occupy the *Clyde* until the middle of January.

3. After completing the survey of Amherst, the *Clyde* should leave for Diamond Island, re-measuring the difference of longitude between Amherst and the island, thus determining the latter position with regard to the former by the most rigorous method.

4. The survey of Akyab, which was commenced by Lieutenant Jarrad and his assistants last season, was suddenly stopped by an outbreak of cholera on board the *Clyde*, which resulted in the death of Sub-Lieutenant George, R. N., the senior assistant. The health of the officers and crew was so unsatisfactory as to cause me to order Lieutenant Jarrad to suspend his operations at that port. He had, however, obtained the main triangulation, and I propose that the *Clyde* should, after obtaining observations at Diamond Island, proceed to complete the survey of Akyab harbour and its approaches.

5. I would suggest that, on the way there, the *Clyde* should visit and examine the entrance to Sandoway river. The Chief Commissioner of British Burmah has addressed me on the subject, and forwarded a correspondence from Colonel Sladen, the Commissioner of Arakan, urging the desirability of such an examination, and pointing out the great inconvenience caused to the public service on account of the mail steamer anchoring outside the bar, when it is believed from local report that they could anchor inside the river. Without a chart however, it is but reasonable that the commanders of the mail steamers should object to risk the safety of their vessels. I therefore quite concur with Colonel Sladen, that there should be, as soon as possible, a survey made of this locality. This service would occupy about a fortnight.

6. The survey of Akyab will embrace the Oyster Reef and Heckford patch, and include^a a much larger area than that originally contemplated, and it will probably require at least two months to complete. Should time admit, I propose the *Clyde* should then proceed to Kyouk Phyou and continue the work commenced there last season. A part of the time would be devoted to dredging in each locality.

7. The *Constance* is so ill-adapted for surveying service in every way, that I think it most undesirable to fit her out again. I therefore propose that this vessel be removed from the Marine Survey, and will address the Government on the subject in a separate letter. The saving effected by this measure will furnish more ample funds than we require for the useful operations mentioned in the next paragraph.

8. My visit of inspection to the Mergni Archipelago clearly shews to me that by the aid of additional soundings and an examination of the dangers contiguous to the navigable channels (which, though well known to the Chinese pilots and native fishermen, are not laid down on the Admiralty charts), the existing charts would suffice for the immediate requirements of commerce and navigation. With this object in view, I made enquiry of the British India Steam Navigation Company what would be the hire of one of their small steamers for two months, from middle of January to the middle of March. They give the approximate cost at Rs. 20 per ton, which is too high. I would therefore propose to utilise the *Ava Steamer*,* attached to British Burma, when, with one assistant to accompany me, I could undertake to complete all that I consider is at present absolutely necessary in that locality. Ultimately as trade increases, yet not for many years, a more rigorous examination would of course become necessary. An estimate of the cost may be given after I have been able to communicate with the Chief Commissioner of British Burma or the Master Attendant of Rangoon, if the sanction of Government be accorded to my doing so.

9. There would on the above cruise be a good opportunity of dredging and for various researches in natural history; and should the Government approve of this part of my programme, I propose that Dr. Armstrong, the Naturalist attached to the *Clyde*, should accompany me for the purpose of investigating the fauna and flora of these hitherto but little known islands.

10. I have also to ask for the sanction of the Government to my visiting, with a view of ascertaining the immediate wants as regards navigation, all the ports on the Coromandel Coast which are touched at by the British India Steam Navigation Company's vessels from Falee

* Since reported as unseaworthy.

Point southward as far as Tuticorin, or perhaps up to Beypore. I would then be in the same position to give an opinion on any nautical question relating to either lighting, buoying, or the general navigation of this east coast of India, as I am concerning the west coast from Beypore northwards, and with respect to the Arakan, Pegu and Tenasserim coasts, which were visited by me recently.

11. Should His Excellency approve of the above proposal, I would propose to leave Calcutta in one of the steamers of the British India Steam Navigation Company about September 12th, returning from Beypore or Tuticorin to Madras by rail, and thence by British India Steam Navigation Company's steamer to Calcutta, and arriving about 22nd October, after having had second opportunities of seeing all ports between the two latter places. The approximate cost of this trip is given in Appendix, and this item has been allowed for in my budget estimate for the current year under the head of Inspection tours.

12. Again I would venture to call the attention of His Excellency the Governor-General in Council to the urgent necessity for hastening the completion of the steamer mentioned in His Excellency's despatch to the Secretary of State, dated Simla, 24th August 1875. It is impossible with the present vessel to execute the surveys either economically, rapidly or satisfactorily.

A. DUNDAS TAYLOR,

CALCUTTA, DECEMBER 1876.

Commander (late I. N.),

Superintendent of Marine Surveys.

